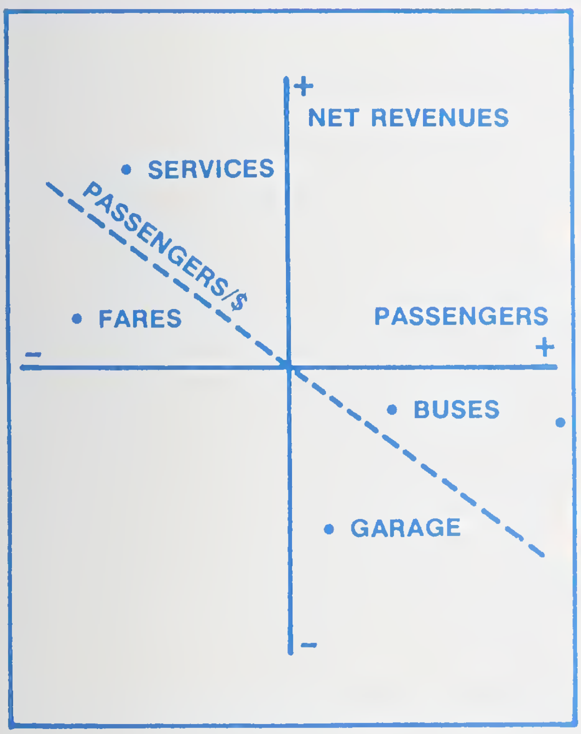
U.S. Department of Transportation

# Transit Corporate Planning

## A Methodology for Trading Off Fares, Service Levels, and Capital Budgets

July 1985




UMTA Technical Assistance Program

# Transit Corporate Planning

## A Methodology for Trading Off Fares, Service Levels, and Capital Budgets

Final Report
July 1985

Prepared by
Armando M. Lago
Ecosometrics, Inc.
4715 Cordell Avenue
Bethesda, Maryland 20590

Prepared for
Office of Service and Management Demonstrations
Urban Mass Transportation Administration
Washington, D.C. 20590

Distributed in Cooperation with
Technology Sharing Program
Office of the Secretary of Transportation

**DOT-I-87-12**

ACKNOWLEDGEMENTS

This report was written in response to a request from Mr. Bert Arrillaga, then Chief of the Pricing Division of UMTA's Office of Service and Methods Demonstration. He saw the need for a document incorporating elements of the transit corporate planning experience in the United States and abroad. Several other persons contributed advice and suggestions to make this report possible. At London Transport Executive, discussions were held with Dr. Peter H. Collins, Mr. Malcom H. Fairhurst, Mr. Andrew J. Jukes, Mr. Ian Phillips (Controller), and especially with Dr. David A. Quarmby, Managing Director (Buses), who graciously contributed his papers and insights. Dr. David Bayliss of the Greater London Council provided explanations on the scope of transit corporate planning in England. At the National Bus Company in Birmingham (England), Mr. Andrew A. Kilner provided explanations on the corporate planning practice at his company. Dr. Alex E. Metcalf, Managing Director, TRANSMARK/British Rail provided insights and criticisms of the British experience with corporate planning in the public sector. At Ecosometrics Inc., Mr. Patrick Mayworm participated in the earlier discussions and Ms. Sue F. Knapp and Mr. Frederic D. Fravel reviewed and corrected the draft report.

Armando M. Lago
Principal Investigator

TABLE OF CONTENTS

# EXECUTIVE SUMMARY

## BACKGROUND

The financial environment in which the transit industry is operating is rapidly changing. Transit boards, city councils, and general managers are facing difficult decisions regarding fare increases, service curtailment, and how to use available funds provided by Federal, state, and local government sources to meet pressing public transportation needs in their communities.

There is an increasing realization that perhaps the managerial and financial planning tools used by the transit industry are not up to the difficult task of coordinating and deciding on fares, services and capital budgets, and that perhaps business planning tools and processes need to be applied in American transit settings.

One of the problems with transit planning and management is that fare and service level decisions are rarely planned and considered together despite the fact that fares and service levels are intrinsically related. Indeed, current transit planning and managerial practices in place emphasize separate analysis of appropriate fares, service levels, and capital budgets with the concomitant result that there is no overall balance between these three important elements because all three are planned and their feasibility determined using different yardsticks and evaluation criteria.

Setting fare and service levels efficiently requires that transit management decide on goals and objectives for the organization; that is, that management (whether it be a transit board or city council) identifies the specific objective for providing transit service and the constraints under which the organization must operate. This process, sometimes known as "corporate planning," involves setting goals for the transit company and determining a yardstick against which all actions are measured.

## IDENTIFICATION OF CORPORATE OBJECTIVES AND CONSTRAINTS

The essence of transit corporate planning is the process of adopting corporate objectives which reflect the community service aims of transit and translating these objectives into performance standards for balancing fares and services in conjunction with the revenue and capital needs of transit operations.

Corporate goals and objectives for operating policies and investment planning are common to all large organizations. The corporate goal refers to the most important or highest achievement that the corporation intends to attain. It is used as a standard to gauge operating and investment policies of the corporation. The corporate objectives translate the corporate goal into intended achievements whose pursuit will accomplish the corporate goal. The objectives are specific in nature, have to be clearly defined, capable of being quantified and objectively measured, monitored, and evaluated. A goal without specific measurable objectives is generally useless.

The corporate planning process must also consider the constraints faced in the achievement of goals and objectives. Corporate objectives and constraints are combined into performance criteria, which enable measurement of whether the objective is being achieved. The final step in corporate planning is the development of decision rules, which translate the objectives into unequivocal measurable standards whose application will result in the achievement of the corporate objective.

### Selecting Transit Objectives

The first task in implementing a corporate planning process consists of developing a list of objectives unique to the transit property and then prioritizing and selecting between conflicting objectives.

Most transit objectives appear to cluster around three major categories: 1) efficiency objectives, 2) effectiveness objectives, and 3) overall objectives. The efficiency objectives relate to the use of resources such as labor, vehicles, equipment, and fuel required to produce output. The efficiency objectives are usually measured in terms of resource usage rates per vehicle mile or per hour of service.

Effectiveness-related objectives include elements of the quantity and quality of the service provided as well as impacts on social goals such as highway traffic congestion. While efficiency objectives are clearly within the complete control of transit authorities, effectiveness objectives are less amenable to complete control. A difference between the two sets of objectives is that while efficiency objectives refer to "doing things right," effectiveness objectives are concerned with "doing the right things." Examples of effectiveness objectives are: area coverage, reduction of transfers, increased service reliability, safety, and attraction of auto rides.

A third set of objectives concern the overall objectives of the transit system. These overall objectives combine efficiency and effectiveness measures with each other or with the cost of providing the service. Examples of overall objectives are: passengers per dollar of cost, operating ratios, and farebox revenue per vehicle mile, among others.

## Prioritizing Objectives

The set of objectives prepared for a transit company must be prioritized as to their relative importance. In this respect, the categories of objectives noted earlier follow an implicit hierarchical structure, with the overall objectives being the most important objectives affecting the success or failure of the entire organization. The determination of the highest priority objective is central to the development of performance criteria. Indeed, proper managerial practice should strive for the maximization or achievement of the highest priority objective, while also attempting to satisfy the requirements and targets of the objectives of lesser importance. Following this practice, one of the overall objectives would be selected as the highest priority objective, whose achievement is maximized, while efficiency and effectiveness objectives of lesser importance are deemed as sub-objectives.

The APTA guidelines[1] suggest that overall objectives related to ridership constitute the highest priority objective. There is good rationale for selecting ridership objectives as the top priority. Ridership objectives correspond to benefits to transit users, an important consideration given the fact that transit remains a community service rendered in a quasi-governmental setting. Benefits to transit users are usually dependent on frequent usage, that is, passenger trips or passenger mileage. If the intent of the transit property is to maximize the benefits to transit users, and fulfilling its community service orientation, then the maximization of ridership should become the objective of highest priority.

## DEVELOPING A PERFORMANCE STANDARD: THE PASSMARK CONCEPT

After the corporate goal and objectives are selected, the next step in the corporate planning approach is to determine the appropriate performance standard for the relevant objective. The performance standard is usually designed by comparing the objective being measured to the major constraint on its achievement.

The objective of maximizing ridership was deemed to be the highest priority objective because of its close relationship to the concept of transit user and community benefits. If the major constraint to providing maximum possible ridership is the external subsidy level, then the performance standard may be evaluated as:

$$\begin{pmatrix}\text{Performance}\\ \text{Standard}\end{pmatrix} \simeq \frac{\text{Objective}}{\text{Constraint}} = \frac{\text{passenger trips (ridership)}}{\text{dollar of subsidy requirements}}$$

The performance standard of "passenger trips per dollar of subsidy" (or per dollar of net costs) becomes the single yardstick which can be used for evaluating the appropriateness of both transit operating policies and capital projects.[2] That is, the consequences of every policy and capital project may be evaluated in terms of its impact on a) passenger trips or ridership, and b) finance or subsidy requirements. Projects and policies can have positive or negative effects on passenger trips or on the financial subsidy requirements.

---

[1] American Public Transit Association. "Revised Policy Statement, Transit Performance." Washington, D.C., 1979.

[2] While passenger miles provide a more appropriate criteria for measuring user benefits and ridership, these figures are generally unavailable in most American transit properties. Instead, a second best measure, passenger trips, are selected for the performance standard.

Projects that increase both passenger trips and gain funds either through revenue increases or cost decreases should clearly be undertaken. In the same vein, policies and projects which increase passenger trips at no extra cost, or result in cost reductions but have no effect on passenger trips, should also be undertaken. The hard policy evaluation questions refer to policies which gain revenues but result in passenger-trip losses (such as fare increases) and policies which increase passenger trips but at extra costs (such as service improvements and some capital projects). Evaluations of these policies and projects require a trade-off between passenger trips and their net revenue impacts or subsidy requirements; these analyses require the quantification of the performance standard.

## Quantification of the Performance Standard

The performance standard, defined in terms of "passenger trips per dollar of net costs" may be referred to as the return standard, the performance yardstick, or simply the passmark. Determination of the level of the passmark or performance standard requires estimating the effect of each policy on both passenger trips and subsidy requirements and selecting the best projects until the subsidy constraint is met. The "passenger trips per dollar of net costs" corresponding to the marginal project/policy becomes the passmark level. That is, the passmark level is the one that meets the budget constraint, so that the passmark value varies according to the budget constraint levels. However, there is a lower limit to the range of possible passmark values. This lower limit is determined by the alternative of raising or lowering fares depending on the circumstance.

### Lower Limit of Performance Standard

Estimating the quantitative level of the performance standard begins by determining its lower limit. The lower limit of the passmark or performance standard is given by the option of changing fares. After all, if there is a revenue shortfall there is always the option of increasing fares or, alternatively, of reducing fares if the external subsidy level is increased.

If the only major constraint is the budgetary or subsidy level constraint, the lower limit of the passmark is given by the passenger trip loss from a small fare increase (or gained from a small fare decrease). This estimate of the lower limit of the passmark in terms of marginal changes in fares and passenger trips can be expressed as the absolute value of the ratio of the small change in passenger trips to the small change in fare revenues, such as in the following expression:

$$\text{Passmark} = \frac{\text{Small Change in Passenger Trips}}{\text{Small Change in Fare Revenues}} = \left| \frac{1}{MR} \right| = \left| \frac{1}{f\left(1 + \frac{1}{\mathcal{E}_f}\right)} \right|$$

where:

MR = marginal revenue

f = average fare per passenger

$\mathcal{E}_f$ = fare elasticity, and

$| \; |$ denotes absolute values

The definition of the lower limit of the passmark, shows the passmark as equal to the inverse of the marginal revenue (or change in fare revenues due to small changes in passenger trips).

The meaning of the passmark is as follows: projects and policies should be undertaken if the passenger trips gained by the project or policy per dollar of net cost exceeds the passmark level, or if the passenger trips lost per dollar gained is less than the passmark. The policies and projects that pass this screening process are now candidates for further evaluation. Those that do not pass this simple test are termed "unfeasible" in terms of maximizing ridership, since they are inferior to simple fare policies for accomplishing the transit authority's corporate objective.

Determination of Net Returns and Rankings of Projects and Policies

The determination of the passmark's lower limit provides the transit planner with the tool for trading-off passenger trip impacts and dollar impacts or net revenues. The passmark value enables us to "value" passenger trip impacts into dollars. The next step is to use the lower limit of the passmark to convert passenger trip impacts for each policy or project into dollar equivalents.

This value essentially represents the gross return on the project. However, the determination of net returns requires consideration of revenues and annualized costs adjusted to reflect the presence of Federal subsidies. The following expression may be used to estimate net returns:

$$\text{Net Returns} = \left(\frac{\text{Passenger Trips}}{\text{Passmark}}\right) + \left(\begin{array}{c}\text{Adjusted}\\ \text{Revenues}\end{array}\right) - \left(\begin{array}{c}\text{Adjusted}\\ \text{Annualized Costs}\end{array}\right)$$

The lower limit of the passmark value is introduced into the above expression to compute the net returns for each project or policy under consideration. Projects or policies whose net returns are negative may be eliminated from consideration, since they are inferior to simple fare adjustment policies. Revenues and annualized costs are adjusted to reflect the effect of Federal subsidy policies. Using the lower limit of the passmark, each project and policy return ratio is estimated and projects are ranked in descending order of return ratios. Projects and policies are then selected in descending order of return ratios until the budget or subsidy constraint is met. The "passenger trips per dollar of net cost" corresponding to the marginal project provides the quantitative value of the performance standard or passmark.

## An Example

Consider the case of a hypothetical transit agency, USA Transit, which has been informed that the Federal commitment for operating subsidies has been reduced by $2.2 million for 1984. This subsidy shortfall must be made up by abandoning some of the capital projects and by considering a combination of fare increases and service reductions. The listing of projects and policies under consideration is presented in Table S-1.

Assuming an average fare revenues per passenger of $0.56 and a -0.3 fare elasticity of demand, the passmark's lower limit can be estimated as follows:

$$\text{Passmark} = \left|\frac{1}{f(1+1/\mathcal{E}_f)}\right| = \left|\frac{1}{0.56\ (1 + 1/-0.3)}\right| = 0.765$$

Table S-1: USA TRANSIT -- NET RETURNS AND RETURN RATIOS OF ALTERNATIVE POLICIES AND PROJECTS -- 1984 -- FINAL

| Policy and Project Options | Passenger Trips ÷ Passmark[a] (1) | Adjusted Net Annualized[b] Costs (2) | Net Returns[c] (3)=(2)-(1) | Return Ratio[c] (4) | Adjusted Net Operating Revenues[d] (5) | Capital Costs (6) | Cumulative Operating Subsidy Requirements[e] (7) | Cumulative Capital Subsidy Requirements: Federal Share (8) | Cumulative Capital Subsidy Requirements: Local Share (9) | Passenger Trips per Dollar of Adjusted Net Costs (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| Regular Bus Replacement Program | 0 | $ -171,496 | $+171,496 | Not Defined | $+330,000 | $6,000,000 | $ -330,000 | $+4,800,000 | $+1,200,000 | Not Defined |
| Articulated Bus Purchase Program | $+217,424 | $ + 46,507 | +170,917 | 4.675 | + 85,580 | 5,000,000 | -415,580 | +8,800,000 | +2,200,000 | 3.670 |
| Passenger Information Aids Projects | + 91,953 | + 59,578 | + 32,375 | 1.543 | - 59,578 | 0 | -356,002 | +8,800,000 | +2,200,000 | 1.212 |
| Service Cuts (-14.5% Change in Bus Miles)[f] | -1333,313 | -1,841,175 | +507,862 | 1.381 | +1,841,175 | 0 | -2,197,177 | +8,800,000 | +2,200,000 | 0.568 |
| Passenger Shelter Program | + 38,205 | + 38,205 | 0 | 1.000 | + 16,795 | 1,877,000 | -2,213,972 | +10,301,600 | + 2,575,400 | 0.785 |
| Fare Increase (+10%) | -551,716 | -541,660 | - 10,056 | 0.982 | + 541,660 | 0 | -2,755,632 | +10,301,600 | + 2,575,400 | 0.800 |
| New Garage Project | +183,906 | +301,039 | -117,133 | 0.611 | + 80,845 | 20,000,000 | -2,836,477 | +26,301,600 | + 6,575,400 | 0.480 |

**Notes:**

a. The passmark's value of |0.785| is used in these computations.

b. Estimated from Table 3-4 (Column 7) in Chapter 3.

c. Estimated from Equations (3.8), (3.9), and (3.10) using adjusted cost figures reflecting the Federal capital subsidy (See Chapter 3).

d. Estimated from Table 3-4 (Column 6) in Chapter 3.

e. No adjustment is necessary for the effect of Federal operating subsidies since USA Transit subsidy requirements exceed the UMTA ceiling on Federal operating subsidies.

f. The service cut policy results in a loss of 1,046,650 passenger trips but in a gain of $1,841,175 in net revenues.

Using "0.765 passenger trips per dollar of net cost" as the lower limit of the passmark, the following projects in Table S-1 are deemed feasible or acceptable: the articulated bus purchase program, the passenger information aids program, the service cut program, and the passenger shelter program. One capital project, the new garage project, cannot be accepted in its present design since it results in small increases in passenger trips per dollar cost. It is clearly preferable to undertake fare changes than to undertake this project. Perhaps a smaller size garage or one that results in significant operating cost savings should be contemplated. The fare increase program also fails the passmark test, suggesting that fare levels are already higher than warranted and out of balance with service levels.

The final value of the passmark is given by the passenger trips per dollar of the marginal project, or that which exhausts the subsidy constraint of generating $2.2 million to offset the reduction in Federal subsidies. The marginal project is the passenger shelter program, whose 0.785 passenger trip dollar becomes the new passmark level. This final passmark level exceeds the preliminary 0.765 passenger trips per dollar passmark level. In the end the passmark value is determined by the level of the subsidy, the distribution of feasible projects and policies, and the appropriateness and political acceptability of fare changes.

## Simple Decision Rules

After determining the value of the passmark which meets the subsidy level, the following decision rules can be advanced:

a. Accept all projects which both save money and increase passenger trips.

b. Accept all projects which save money at no loss in passenger trips or gain passenger trips at no loss in net revenues.

c. Accept all projects which gain more than 0.785 passenger trips per dollar loss.

d. Accept all projects which lose fewer than 0.785 passenger trips per dollar gained.

### A Graphical Representation

The evaluation of policies and projects using the passmark concept of passenger trips per dollar is illustrated in Figure S-1. In this diagram, projects and policies are plotted according to their effects on passenger trips and net revenues. The dashed diagonal line represents the performance standard or passmark of 0.785 passenger trips per dollar. The acceptable projects and programs are portrayed to the right and above the passmark line. Unacceptable projects appear below and to the left of the passmark line. The marginal project appears on the passmark line. As may be seen from Figure S-1, the fare increase policy and the new garage project are to the left of the passmark line in the unacceptable zone.

The utility or usefulness of the performance standard or passmark is that it allows one to trade projects and policies. By altering the slope of the diagonal line, it is possible to either include more projects of the money saving type or conversely more projects of the passenger trips generation type. The slope of the line is thus determined by the subsidy level or availability of monies. The less money is available, the further the line must be rotated in a counter clockwise direction in order to cut out the money losing projects and increase the number of money gaining projects. The passmark or performance standard provides the transit planners with a tool to allocate the subsidy among competing projects and policies while accomplishing the corporate objective of maximizing ridership.

## BALANCING FARE AND SERVICE LEVELS

One important application of the corporate planning approach is in the synchronization of fare and service policies, which in conventional transit planning applications are usually planned somewhat independently of each other.

### Rules for Balancing Fares and Service Levels

Balancing fares and service levels entails finding the optimal combination of fares and service levels which meet the budget constraint while maximizing ridership. This optimal balance is arrived at when the passenger trips per dollar of net cost of small changes in both fares and service options are

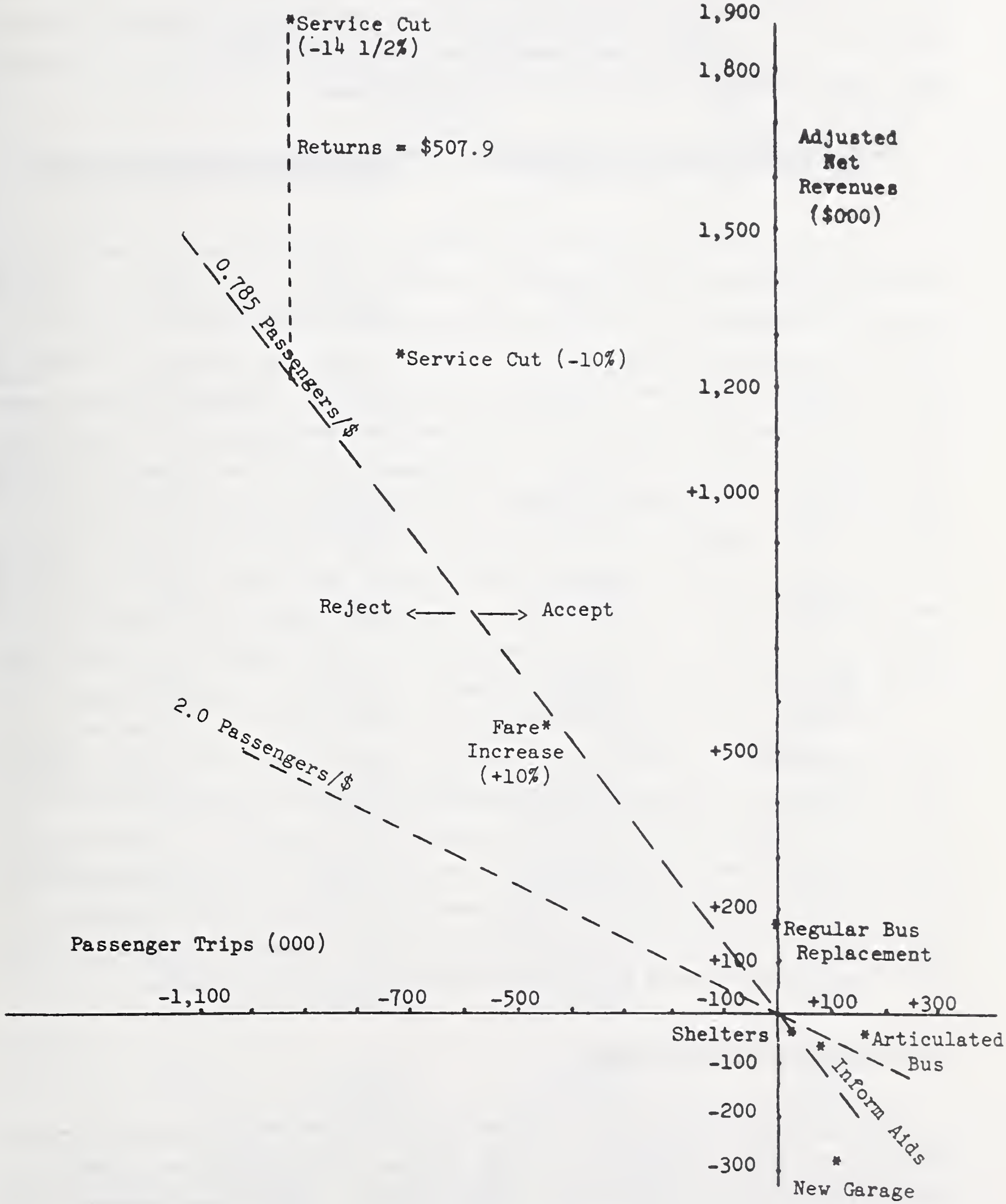



Figure S-1: USA TRANSIT -- GRAPHICAL REPRESENTATION OF DECISION RULES USING THE PERFORMANCE STANDARD OR PASSMARK approximately similar. That is, for optimal fare and service balance, the passenger trip loss (gains) per dollar of net revenue gain (loss) from small service reductions (increases) must equal the passenger trip gains (loss) per dollar of net revenue loss (gain) from small fare reductions (increases). This optimal balance condition may be expressed as:

$$\frac{\text{loss (gain) in passenger trips from small service changes}}{\text{dollar gains (loss) from small service changes}} = \frac{\text{gain (loss) in passenger trips from small fare changes}}{\text{dollar loss (gains) from small fare changes}}$$

In terms of the hypothetical USA Transit example presented earlier, the appropriate balance between fare and service levels is arrived at by estimating the combination of fare and service changes which generates the required savings in operating subsidies with a minimum loss in ridership. Table S-2 presents the combinations of fares and service level changes required to generate approximately $1.85 million in net revenues, assuming service elasticities are constant and fare elasticities are proportional to the average fare paid per passenger. The optimal balance between fare and services is achieved at Option 8 which specifies a 25 percent cut in fares and a 25.3 percent reduction in bus miles. Option 8 generates the required net revenue target at minimum passenger trip loss, as indicated by its lower average passenger trips per dollar of net cost. At this option the ratios of passenger trips per dollar of net cost for small (marginal) changes in fares and services are equal.

In light of the results presented in Table S-2, the budget balancing solution presented in Table S-1 is clearly inefficient. Rather than reducing bus miles by 14 1/2 percent, the appropriate or optimal balancing solution would have been to reduce fares by 25 percent and reduce service (bus miles) by 25.3 percent. Fares and service policies therefore, cannot be planned independently of each other, because there is a loss associated with their lack of synchronization or balance. This loss is reflected in greater reductions in ridership than would have been warranted by policies which are optimally balanced.

## Adjusting Service Level Changes

The next step in the fare and service coordination process is to adjust the service level to correspond to the optimal fare and service coordination policies presented in Table S-2. This optimal service coordination policy required a 25.3 percent reduction in bus miles supplied. Suppose that USA

Table S-2

USA TRANSIT

ALTERNATIVE FARE AND SERVICE COMBINATIONS
FOR MEETING SUBSIDY REQUIREMENTS -- 1984

| | | Changes in | | Average Passenger |
|---|---|---|---|---|
| Policy Options | | Passenger Trips (000) | Net Costs (000) | Trips Per Dollar |
| Option 1 | | | | |
| Fares: | +30% | -1,494.2 | $-1,337.6 | 1.117 |
| Bus Miles: | -4.5% | - 324.8 | - 516.8 | 0.628 |
| | | -1,819.0 | -1,854.4 | 0.981 |
| Option 2 | | | | |
| Fares: | +10% | - 454.8 | - 528.3 | 0.861 |
| Bus Miles: | -10.75% | - 776.0 | -1,321.6 | 0.587 |
| | | -1,230.8 | -1,849.9 | 0.665 |
| Option 3 | | | | |
| Fares: | +5% | - 222.0 | - 270.5 | 0.821 |
| Bus Miles: | -12.6% | - 909.5 | -1,574.5 | 0.578 |
| | | -1,131.5 | -1,845.0 | 0.613 |
| Option 4 | | | | |
| Fares: | 0% | 0 | 0 | 0 |
| Bus Miles: | -14.6% | -1,053.9 | -1,853.8 | 0.569 |
| | | -1,053.9 | -1,853.8 | 0.569 |
| Option 5 | | | | |
| Fares: | -10% | + 411.4 | + 601.1 | 0.684 |
| Bus Miles: | -18.7% | -1,349.8 | -2,450.1 | 0.551 |
| | | - 938.4 | -1,849.0 | 0.508 |
| Option 6 | | | | |
| Fares: | -15% | + 600.9 | + 926.6 | 0.648 |
| Bus Miles: | -20.9% | -1,508.6 | -2,780.6 | 0.543 |
| | | - 907.7 | -1,854.0 | 0.490 |
| Option 7 | | | | |
| Fares: | -20% | + 779.6 | +1,267.6 | 0.615 |
| Bus Miles: | -23.1% | -1,667.4 | -3,119.9 | 0.534 |
| | | - 887.8 | -1,852.3 | 0.479 |
| Option 8 | | | | |
| Fares: | -25% | + 947.4 | +1,623.2 | 0.584 |
| Bus Miles: | -25.3% | -1,826.2 | -3,468.2 | 0.527 |
| | | - 878.8 | -1,845.0 | 0.476 |
| Option 9 | | | | |
| Fares: | -30% | +1,104.4 | +1,992.4 | 0.554 |
| Bus Miles: | -27.6% | -1,992.2 | -3,839.3 | 0.518 |
| | | - 887.8 | -1,846.9 | 0.481 |

Note: Changes in passenger trips are estimated using mid-point elasticities. Decreases in net costs are identical to increases in net revenues.

Transit allocates costs to its routes on the basis of the following simple cost allocation formula:

$$(\text{Cost}) = 0.73\ (\text{Bus Miles}) + 19.42\ (\text{Hours}) + 11{,}158\ (\text{Peak Vehicles})$$

and determines that Route 21 is among the worst routes in USA Transit's network in terms of passengers per dollar of net revenue. Indeed, the Route 21 returns of 0.23 passenger trips per dollar of net costs are well below the passmark level. In the light of these figures, service should not be provided on this route without extensive modifications.

The task at hand for Route 21 is to change headways or reduce the mileage of the route by cutbacks. Also possible, but not considered here, is a reduction in the span or hours of service. The Route 21 modification options entail reducing service from the four hourly buses currently assigned to the route, to one bus every two hours. The options available and their costs and revenue impacts are presented in Table S-3. Selection of the appropriate option for service along Route 21 should be conducted in terms of the net returns formulas presented earlier. As shown in Table S-3, the net returns (evaluated at the passmark level of 0.785 passenger trips per dollar) are positive only for the reduced service options of 3/4 and 1/2 buses per hour, that is wide headways such as those that prevail in suburban off-peak service. These headway modifications on Route 21 result in reductions of 81 1/4% - 87 1/2% of the bus miles supplied on this route.

Table S-3

USA TRANSIT
RETURNS AND RETURN RATIOS FOR SERVICE OPTIONS ON ROUTE 21

| Route 21 Service Option | Annual Passengers[a] (000) (1) | Annual Passenger Trips ÷ Passmark (000) (2) | Annual Net Costs (000) (3) | Annual Net Returns (000) (4)=(2)-(3) | Return Ratio (5)=(2)÷(3) |
|---|---|---|---|---|---|
| 4 buses per hour | 50.00 | 63.70 | $ 213.90 | $-150.20 | 0.30 |
| 3 buses per hour | 43.75 | 55.70 | 157.80 | -102.10 | 0.35 |
| 2 buses per hour | 37.50 | 47.70 | 101.70 | -54.00 | 0.47 |
| 1 bus per hour | 31.25 | 39.80 | 45.60 | -5.80 | 0.87 |
| 3/4 bus per hour | 29.69 | 37.82 | 31.57 | +6.25 | 1.20 |
| 1/2 bus per hour | 28.13 | 35.80 | 17.55 | +18.25 | 2.04 |

[a]Assumes a +0.5 service elasticity of demand.

## DEVELOPING THE FIVE-YEAR INVESTMENT PROGRAM

The final task in transit corporate planning is the development of the five-year investment program. Capital projects in the investment program may be classified into several categories which differ in their evaluation methodologies. "Like-for-like" replacements and renewals refer to capital projects required to maintain the transit system at the current level of operational efficiency and safety. Acceptance of these essential renewals and replacements of rolling stocks, building structures, etc. is determined in reference to engineering standards or practice. The accepted projects should correspond to the minimum life-cycle cost replacement alternative.

Betterments and new projects include those with and without ridership impacts. Some betterment projects have no impact on ridership and their evaluation should follow conventional capital budgeting techniques, such as estimating the net present value of the investments. Betterments and new projects with impacts on ridership should be evaluated in terms of their "passenger trips per dollar of net cost" and these impact figures need to be compared to the passmark to determine their acceptance or rejection.

### Developing the Investment Program Options

As a starting point, the Transit Board, taking into account external commitments of funds from Federal and state sources, should set the probable level of resources to be spent for capital projects during the five-year period. In this example, a target level of $10 million was set for the capital budget of USA Transit, after taking into account Federal commitments of $40 million for capital subsidies during the five-year period. The Transit Board should ask the planning staff to prepare alternatives including a preferred investment program and several reduced investment options. On the assumption that some level of public transit service is necessary, some level of investment is required. A detailed analysis of the consequences of eliminating all investments comprise so many uncertainties that it would not be meaningful in making decisions. Therefore, the zero investment option is not analyzed. Instead, the focus of the analysis on the quantification of investment returns, analyzing the effects of varying levels of investments over a range which would encompass any likely possible decision. Projects with no effect on ridership are prioritized and grouped into program options along with capital projects with ridership impacts which have the same priority. Table S-4 presents the annualized costs included in each of the reduced investment options under consideration.

## Analyzing Investment Program Options

Analysis of the investment options in terms of ridership and revenue impacts are presented in Table S-5. As shown in this table, the preferred investment program exceeds the capital budget ceiling and in addition is not economically feasible, since the passenger trips generated per dollar of net cost is below the passmark level of 0.785 passenger trips per dollar. Clearly, the preferred program should not be undertaken.

The first reduced program is economically feasible, since its incremental returns in terms of passenger trips per dollar of net cost exceed the passmark level. However, the first reduced program exceeds the capital budget constraint of $10 million of local share funding for the five-year program.

While the second reduced program is economically feasible since its marginal returns exceed the passmark level, the maximum net return option is the first reduced program. Since the first reduced program exceeds the passmark level, it is preferable to raise fares (or to not cut fares by a level as large as shown previously) to undertake this program, given that it is superior to the fare change option.

The choice for the Transit Board is: Do they accept an economically feasible program (i.e., the second reduced program) which is within the budget constraints or do they accept a superior option (i.e., the first reduced program) which also involves fare changes? On strictly economic terms the first reduced program should be adopted and fares raised (or fare cuts limited to levels above the fare reduction recommended previously). However, in the highly political environment surrounding fare changes, factors other than the economic impacts need to be taken into consideration. Only the Board can incorporate the political factors in the final decision.

Submission of the five-year Investment Program provides a management control focus while displaying the bids for resources made by the capital projects under consideration. The five-year Investment Program also brings to focus decisions regarding the overall allocation of resources between operating and capital funds by indicating an optimum split between these two uses of funds.

Table S-4

USA TRANSIT
PRIORITIZATION OF FIVE-YEAR INVESTMENT PROGRAM OPTIONS
(millions of 1984 dollars)

| Investment Program Options | Federal Share Costs (1) | LOCAL SHARE COSTS All (2) | Replacement Projects (3) | Betterments and New Projects: Without Ridership Impacts (4) | Betterments and New Projects: With Ridership Impacts (5) |
|---|---|---|---|---|---|
| **Preferred Program** | | | | | |
| New Garage | $ 16.0 | $ 4.00 | $ -- | $ -- | $ 4.00 |
| Bus Stations Improvements | 6.0 | 1.50 | -- | 1.50 | -- |
| Bus Radio & Communications | 2.8 | 0.70 | -- | 0.70 | -- |
| Staff Safety | 4.0 | 1.00 | -- | 1.00 | -- |
| Projects in 1st Reduced Program | 53.0 | 13.30 | 4.50 | 0.54 | 8.26 |
| | $ 81.8 | $20.50 | $4.50 | $3.74 | $12.26 |
| **First Reduced Program** | | | | | |
| Articulated Buses | $ 12.0 | $ 3.00 | $ -- | $ -- | $3.00 |
| Passenger Safety & Amenities | 3.0 | 0.80 | -- | 0.27 | 0.53 |
| Projects in 2nd Reduced Program | 38.0 | 9.50 | 4.50 | 0.27 | 4.73 |
| | $ 53.0 | $13.30 | $4.50 | $0.54 | $8.26 |
| **Second Reduced Program** | | | | | |
| Park-and-Ride Lots | $ 16.8 | $4.20 | $ -- | $ -- | $4.20 |
| Passenger Information Aids | 3.2 | 0.80 | -- | 0.27 | 0.53 |
| Projects in 3rd Reduced Program | 18.0 | 4.50 | 4.50 | -- | -- |
| | $ 38.0 | $9.50 | $4.50 | $0.27 | $4.73 |
| **Third Reduced Program** | | | | | |
| Conventional Bus Replacement | $ 9.6 | $2.40 | $2.40 | $ -- | $ -- |
| Conventional Garage Renovation | 8.4 | 2.10 | 2.10 | -- | -- |
| | $ 18.0 | $4.50 | $4.50 | $ -- | $ -- |

Table S-5: USA TRANSIT -- ANALYSIS OF INCREMENTAL CHANGES BETWEEN PROGRAM OPTIONS 1984 - 1988
(in millions of 1984 dollars, unless otherwise specified)

| Investment Program Options: Programs | Investment Program Options: Project Types | Adjusted Annualized Non-Federal Capital Costs (1) | Revenues and Operating Cost Savings Generated (2) | Average Annual Passenger Trips Generated (millions) (3) | Average Annual Passenger Trips Per Dollar of Adjusted Net Costs (4)=(3) ÷ [(1)-(2)] |
|---|---|---|---|---|---|
| Preferred Program | All Projects | 2.73 | $1.17 | 1.18 | 0.756 |
| | Projects with Ridership Impacts | 1.65 | 0.51 | 1.18 | 1.035 |
| 1st Reduced Program | All Projects | 1.84 | 1.09 | 1.04 | 1.387 |
| | Projects with Ridership Impacts | 1.27 | 0.43 | 1.04 | 1.238 |
| 2nd Reduced Program | All Projects | 1.29 | 0.92 | 0.65 | 1.757 |
| | Projects with Ridership Impacts | 0.75 | 0.26 | 0.65 | 1.326 |
| 3rd Reduced Program | All Projects | 0.52 | 0.66 | 0.00 | Not Defined |
| | Projects with Ridership Impacts | 0.00 | 0.00 | 0.00 | Not Defined |
| Incremental Changes Between Options: | | | | | |
| Cut from preferred to 1st reduced program | All Projects | $0.89 | $0.08 | 0.14 | 0.173 |
| | Projects with Ridership Impacts | 0.38 | 0.08 | 0.14 | 0.467 |
| Cut from 1st reduced to 2nd reduced program | All Projects | 0.55 | 0.17 | 0.39 | 1.026 |
| | Projects with Ridership Impacts | 0.52 | 0.17 | 0.39 | 1.114 |
| Cut from 2nd reduced to 3rd reduced program | All Projects | 0.77 | 0.26 | 0.65 | 1.275 |
| | Projects with Ridership Impacts | 0.75 | 0.26 | 0.65 | 1.326 |

Note: Some projects such as the passenger information aids and the passenger safety and amenities, include components with and without ridership impacts. See Table S-4.

## CONCLUSIONS

The essence of the transit corporate plan is the process of planning and decision-making, of adopting corporate objectives which reflect the public service aims of transit service, of evaluating alternatives and of developing standards to balance the revenue and capital needs of transit operations. Transit corporate planning techniques, some borrowed from European practice, are ready to be experimented and demonstrated in American transit settings. There is hope that the next few years will witness increased interest and the actual implementation of these corporate planning concepts and techniques.

# 1

CORPORATE PLANNING AND TRANSIT POLICY

IDENTIFYING CORPORATE OBJECTIVES AND CONSTRAINTS

DEVELOPING A PERFORMANCE STANDARD

BALANCING FARE AND SERVICE LEVELS

DEVELOPING THE FIVE-YEAR INVESTMENT PROGRAM

# 1

## CORPORATE PLANNING AND TRANSIT POLICY

### BACKGROUND

The financial environment in which the transit industry is operating is rapidly changing. The declining Federal role in subsidizing mass transit operations has accentuated a growing financial squeeze facing the transit industry. Transit boards, city councils and general managers are facing difficult decisions regarding fare increases, service curtailment, and how to use available funds provided by Federal, state and local government sources to meet pressing public transportation needs in their communities.

There is an increasing realization that perhaps the managerial and financial planning tools used by the transit industry are not up to the difficult task of coordinating and deciding on fares, services and capital budgets, and that perhaps business planning tools and processes need to be applied in American transit settings. This report discusses some of the fundamental concepts of a corporate planning framework in an American transit setting, integrating planning elements and tools that have already been applied in some transit settings -- American and foreign.[1]

---

[1]Ronald F. Kirby and Melinda A. Green. "Policies and Procedures for Transit Service Development." Transit Quarterly, July 1979, pp. 413-427.

## BALANCING FARE SERVICE LEVELS AND CAPITAL BUDGET NEEDS

The financial structure of a transit property can be expressed in a simple algebraic formulation that shows that subsidy plus revenue must equal costs:

Subsidy + Revenue = Operating Costs + Capital Costs + Interest on Debt

If, for example, subsidy support diminishes, some of the remaining components in the equation must be adjusted to maintain correspondence between costs and subsidy plus revenue. This same relationship may be expressed graphically by the parallel equal lines shown in Figure 1-1. Looking at the revenue line, as the subsidy support side diminishes; either the farebox revenues have to be increased to cover equal costs or one or more of the segments on the cost line must be adjusted to maintain the correspondence between costs and revenues. The greater the costs of a transit system, the greater the risk or liability it incurs. Generally, greater reliance by a transit system on farebox revenue to cover its costs increases its stability. An analogy can be seen if you think of revenue as the leverage balancing costs. In such an analogy, the costs line in Figure 1-1 would be a weighted bar and the dividing point between the farebox and subsidy segments on the revenue line would be the fulcrum. The farther the fulcrum is along the revenue line, (the greater the proportion of farebox revenue), the greater the leverage and the greater the stability of the transit system.

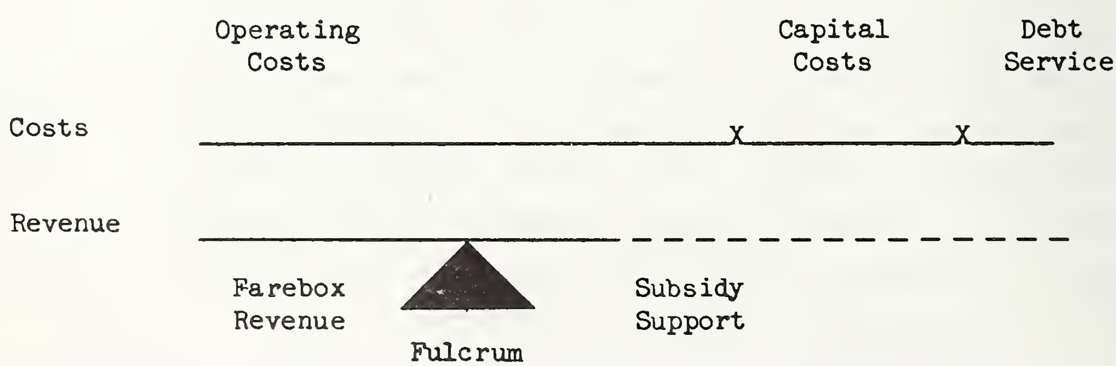



Figure 1-1: THE GRAPHICAL RELATIONSHIP BETWEEN COSTS, FAREBOX REVENUES, AND SUBSIDY SUPPORT

Typically in the wake of subsidy shortfalls, fares are increased and service levels are reduced so that available revenues cover the operating expenses remaining after all outside subsidies are committed. But are these decisions always the best decisions, or are they only temporary solutions designed to pull the transit company through until the political and economic climate changes? A more rational, long-term approach to transit financial planning will have to be adopted soon if transit operators are going to remain viable in the future.

A major problem with transit planning and management is that fare and service level decisions are rarely planned and considered together despite the fact that fares and service levels are intrinsically related. In addition, less traditional fare and service concepts are seldom given serious consideration when major policy changes are under review. Some interesting concepts include conversion from conventional service to paratransit (vanpools and taxi feeders), conversion of some services to quality-based services with truly premium fares, and developing private sector assistance and support (through merchant involvement, business support of specific services, and employer-subsidized pass programs).

Current managerial and planning processes in place at most transit properties achieve some low level of planning coordination between fares, services and capital budget needs in spite of being conducted by different departments within the organization. Thus, the planning of fare levels (conducted usually by planning staff) take into account service levels (specified by operations staff) and costs, as well as the revenue required to finance capital equipment needs (determined by the financial staff). However, these planning processes and practices mostly emphasize separate analysis of appropriate fares, service levels and capital budgets with the concomitant result that there is no overall balance between these three important elements because all three are planned and their feasibility determined using different yardsticks and evaluation criteria.

This tendency to plan for and consider fares, service levels, and capital budgets in isolation of each other, and to think of fare levels only in terms of what it will do to the financial condition of the transit property, results in a lack of proper balance between these three important elements. Indeed, hardly ever is the question asked of whether money lost by holding fares down might produce more ridership and revenues if it were spent maintaining or increasing services. The result is that some properties might have higher fares and lower service levels (or vice versa) than would be appropriate if proper coordinating policies had been followed. That is, fares and service levels may not be in balance in most properties.

Setting fare and service levels efficiently requires that transit management set goals and objectives for the organization; that is, that management (whether it be a transit board or city council) has identified the specific objective for providing transit service and the constraints under which the organization must operate. This process, sometimes known as "corporate planning," involves setting goals for the transit company and determining a yardstick against which all actions are measured.

## CORPORATE PLANNING

A Corporate Plan summarizes the results of planning exercises whose purpose is the achievement through time of the corporation's goals and objectives. The end result of these planning exercises is the Corporate Plan which integrates revenue growth and long run profitability of a corporation with capital budgets, investments, and acquisition programs. While the time period covered by the Corporate Plan varies according to the nature of the corporation's business, particularly the longevity and gestation period of its investment, a five-year projection period is most common.

The principal elements of the corporate planning approach include:

1. Objectives. The private corporation must decide from a variety of objectives referring to either rate of growth of net worth, rate of growth of earnings per share or even rate of growth of dividends, among others.

2. Constraints. The private corporation must take into account constraints affecting its performance such as availability of funds, cost of capital for the corporation, and external conditions exemplified by the business cycle and conditions in the stock and bond markets.

3. Decision Rules. On the basis of the corporation's objective and constraints, decision rules for judging the feasibility of some operating policies and capital investments are designed. The typical yardstick in capital budgeting decisions is the cut-off or marginal rate of return, which in the absence of constraints on availability of funds is equal to the market rate of interest or the marginal cost of funds. Projects that earn rates of return below the marginal rate of return will not be funded. (If a corporation has to pay more to borrow the money to pay for the investment than it can realize from the investment, then it is not worth it.)

4. Strategy and Projections of Activity. The private corporation decides on a strategy for achieving its corporate objective and the expected results of its plan in terms of sales, profitability, earnings per share and other important activity measures.

Giving due consideration to both the importance of political factors and the multi-objective nature of managerial considerations in transit properties, there is nothing inherent in transit settings per se that would restrict the applicability of the corporate planning approach to transit planning and management. The corporate planning application to transit planning distinguishes the following sequential tasks:

- Identifying Corporate Objectives and Constraints
- Developing a Performance Standard
- Balancing Fare and Service Levels
- Developing the Five-Year Investment Program

The next chapter discusses these analytical tasks of a corporate planning approach to the joint determination of transit fares, service levels, and capital budgets.

# 2

CORPORATE PLANNING AND TRANSIT POLICY

**IDENTIFYING CORPORATE OBJECTIVES AND CONSTRAINTS**

DEVELOPING A PERFORMANCE STANDARD

BALANCING FARE AND SERVICE LEVELS

DEVELOPING THE FIVE-YEAR INVESTMENT PROGRAM

# 2

## IDENTIFYING CORPORATE OBJECTIVES AND CONSTRAINTS

### ON CORPORATE OBJECTIVES

Corporate goals and objectives for operating and investment planning are common to all large organizations. They are used to direct the planning and decision-making process so that all available resources are used to achieve the best value. The corporate goal establishes the basic direction and purpose of the organization.

As a rule, goals which are vaguely defined are generally useless as statements of the corporation's overall intentions and plans. Goals must be defined in such a manner that the progress towards achievement of these goals may be measured or monitored. For the statement of goals to be appropriate it must be capable of being translated into a series of objectives and sub-objectives of greater specificity and capable of being measured. For example, the goal statement of providing "fast, safe, and efficient transportation" is meaningless without articulating specific objectives regarding speed, accident records, reliability and costs; that is, without disaggregating the components of the goal statement into sub-components or objectives capable of measurement.

A corporate goal refers to the most important or highest achievement that the corporation intends to perform. The corporate goal, usually long-term in nature, should be used as a standard to gauge operating and investment policies of the corporation. There should be a general correspondence between these policies and the corporate goal. An organization may have several different goals. In this case, they must be prioritized with respect to the relative importance that the Board of Directors assigns to each.

Corporate objectives translate the long-term corporate goal into intended shorter term achievements, whose pursuit will eventually accomplish the corporate goal. The corporate objectives are subsets of the corporate goal but more specific in nature. The objectives have to be clearly defined, capable of being quantified and objectively measured, monitored, and evaluated. In addition, the objectives must be easy to understand. A goal without specific measurable objectives is generally useless.

The relationship between goals and objectives may be described as hierarchical in nature. Goals, defined in a broad general manner, are disaggregated into objectives and sub-objectives of a more specific nature capable of measurement and evaluation of progress towards its achievement. This relationship between goals and objectives is presented with some examples in Figure 2-1.

The corporate planning process must also consider constraints on the achievement of goals and objectives. The constraints may be external to the institution, such as the level of Federal subsidy support or the conditions of capital borrowing markets, or internal to the firm such as its labor availability, collective bargaining contracts, etc.

Analysis of achievement of objectives subject to constraint limitations usually entails development of performance criteria that enable measurement of whether the objective is being achieved. The performance criteria quantify the objective which the institution wants to achieve; that is, they are measurable quantities.

The final step in the hierarchical structure is the development of specific decision rules or performance levels that translate the objective into an unequivocal measurement standard denoting success or failure in achieving the objective.

## ON TRANSIT OBJECTIVES

For years transit companies have survived without clear corporate objectives. The U.S. General Accounting Office (GAO) noted the vast array of goals that have been assigned to transit by Federal, state, and local governments.

| | | | | |
|---|---|---|---|---|
| GOAL: | Best Levels of Service | Reliable Transit | Most Benefits to Transit Users | Equity of Area Coverage |
| OBJECTIVE: | Improved Schedules | Improved Schedule Adherence | Maximum Ridership Increase Through Fare Change | Expand Service to New Areas |
| CONSTRAINT: | Available Budgets/ Subsidy | Budgets for Back-up Vehicles/ Crews & Preventive Maintenance | Available Level of Subsidy | Costs and Subsidy Levels |
| PERFORMANCE CRITERIA: | Additional Passengers Per Dollar Cost | Trips on Time Per Dollar Cost | Passengers Gained Per Dollar of Lost Revenue | Passengers Gained Per Dollar Cost |
| DECISION RULE: | One Additional Passenger Per Dollar of Net Revenue Loss | 1,000 Daily Trips Arrive Within 5 Minutes Per Dollar Cost | One Passenger Per Dollar of Net Revenue Loss | One Passenger Per Dollar of Net Revenue Loss on New Routes |

Figure 2-1: EXAMPLES OF HIERARCHICAL STRUCTURE OF GOALS, OBJECTIVES, AND CRITERIA FOR PERFORMANCE

Goals that, in addition, were poorly defined, not prioritized in any sense, and even conflicted in some cases. The end result, argued GAO, is confusion in what transit is supposed to do, and an inability to determine what transit is actually accomplishing.[1]

GAO claimed that the transit industry is in such a state due to its inattention to proper planning. As early as 1958, the National Committee on Urban Transportation[2] had specified transit service objectives, as well as standards and measurement techniques. However, this earlier effort, which in fact initiated some of the transit performance measures in use today, went largely unnoticed by the transit industry.

A survey of transit properties in Pennsylvania and nationally found that, irrespective of size of operation, "most systems did not have a formalized set of stated objectives that have been specifically adopted or utilized as guidelines for system operations."[3] The survey also found that some properties did have objectives mentioned in Transit Development Plans (TDP) and/or Transit System Management (TSM) Plans but that, in some instances, these were too vague or general in nature.

The American Public Transit Association (APTA) is advocating a "National Performance Program"[4] which emphasizes the development of objectives and performance standards for internal managerial purposes, but neither for external appraisal nor for government funding purposes. The approach presented in this report and detailed in subsequent chapters fits into that internal management perspective.

---

[1]Bonnell, R.J. "Transit's Growing Financial Crisis." Traffic Quarterly. Vol. 35, No. 4, October 1981; and U. S. General Accounting Office. Soaring Transit Subsidies Must be Controlled, Report CED-81-28, Washington, D.C., February 26, 1981.

[2]National Committee on Urban Transportation. Measuring Transit Service. Procedural Manual, No. 4A, Public Administration Service, Chicago, Illinois, 1958.

[3]Simpson & Curtin and the University of Pennsylvania. Transit System Performance Evaluation and Service Change Manual. Pennsylvania Department of Transportation, Harrisburg, Pennsylvania, February 1981, p. I-3.

[4]American Public Transit Association. "Revised Policy Statement, Transit Performance." Washington D.C., 1979.

## SELECTING TRANSIT OBJECTIVES

The first task in implementing a corporate planning process consists of developing a list of objectives unique to the transit property and then prioritizing and selecting between conflicting objectives.

Most transit objectives appear to cluster around three major categories: 1) efficiency objectives, 2) effectiveness objectives, and 3) overall indicators.[1] The efficiency objectives relate to the use of factors such as labor, vehicles, equipment, and fuel required to produce output. The efficiency objectives are usually measured in terms of factor usage rates per vehicle mile or per hour of service.

Effectiveness-related objectives include elements of the quantity and quality of the service provided as well as impacts on social goals such as highway traffic congestion. While efficiency objectives are clearly within the complete control of transit authorities, effectiveness objectives are less amenable to complete control. A difference between the two sets of objectives is that while efficiency objectives refer to "doing things right," effectiveness objectives are concerned with "doing the right things."[2]

A third set of objectives concern the overall objectives of the transit system. These overall objectives combine efficiency and effectiveness measures with each other or with the cost of providing the service. Table 2-1 presents a listing of objectives from the survey of Pennsylvania properties mentioned earlier, grouped around the categories of objectives described above.

### Prioritizing Objectives

The set of objectives prepared for a transit company must be prioritized as to their relative importance. In this respect, the categories of objectives noted earlier follow an implicit hierarchical structure, with the overall objectives being the most important objectives affecting the success or failure of the entire organization. While important, the other categories of objectives are of secondary importance and are more of a subset of the overall objectives.

---

[1]Fielding, Gordon J. et. al. Indicators and Peer Groups for Transit Performance Analysis. Institute of Transportation Studies. University of California. Irvine, California. January 1984.

[2]Fielding, Gordon J. Changing Objectives for American Transit. Institute of Transportation Studies. University of California. Irvine, California. July 1982.

Table 2-1: SELECTED OBJECTIVES OF PENNSYLVANIA TRANSIT PROPERTIES

| Category | Objectives | Examples of Performance Criteria |
|---|---|---|
| Overall | Increase Ridership Per Dollar of Cost | 0.5 passengers per dollar of cost |
| | Improve Operating Ratios | 40 percent system-wide revenue/cost ratio |
| | Increase Financial Support/Subsidy Levels | Increase subsidy to $.30 per passenger |
| | Increase Farebox Revenues per Service Unit Provided | $2.00 per vehicle-mile |
| | Increase Vehicle Miles per Dollar of Cost | 0.4 vehicle-miles per dollar of cost |
| Effectiveness | Increase Area Coverage/Service Expansion | 90 percent of urbanized area population within one-quarter mile of a bus line |
| | Improve Levels of Service/Headways | Minimum 60-minute headways during off-peak hours |
| | Attract Auto Users/Reduce Congestion | 25 percent of transit riders would drive own auto |
| | Reduce Transfers | Not to exceed ten percent of ridership |
| | Provide Accessible Service | Assignment of ten percent lift-equipped buses and/or responsive service for special users |
| | Increase Service Reliability | 90 percent trips on time during peak period |
| | Improve Safety/Decrease Accidents | Nine vehicle accidents per 100,000 |
| Efficiency | Increase Vehicle Availability | Less than 0.1 percent missed vehicle trips |
| | Increase Labor Productivity | 17,000 vehicle miles per employee |
| | Increase Energy Use Efficiency | Five vehicle-miles per gallon |
| | Increase Vehicle Replacement Efficiency | Average fleet age of 6-8 years |

Source: Pennsylvania transit properties' objectives grouped by Ecosometrics, Inc. from: Simpson & Curtin and The University of Pennsylvania. Transit System Performance Evaluation and Service Change Manual. Pennsylvania Department of Transportation. Harrisburg, Pennsylvania. February 1981.

For example, while vehicle productivity during off-peak hours is a problem that needs attention, it is certainly secondary in importance to meeting the target operating ratio of the transit property.

The importance of attaching the highest priority to the overall objectives has been documented in several studies. Gordon J. Fielding and his associates at the University of California (Irvine)[1] found performance measures related to overall objectives, such as: vehicle-miles per dollar cost, ridership per dollar cost, and operating ratios as the three most important factors explaining the variability of performance measures of approximately 200 American transit properties. Similarly APTA's policy statement, while recognizing and defining both efficiency and effectivess measures, gives priority to ridership as the key indicator of transit system effectiveness.[2]

## Objective of the Highest Priority: Maximum Ridership

The determination of the highest priority objective is central to the development of performance criteria. Indeed, proper managerial practice should strive for the maximization or achievement of the highest priority objective, while also attempting to satisfy the requirements and targets of the objectives of lesser importance. Following this practice, one of the overall objectives would be selected as the highest priority objective, whose achievement is maximized, while efficiency and effectiveness objectives of lesser importance are deemed as sub-objectives.

The APTA guidelines suggest that overall objectives related to ridership constitute the highest priority objective. There is good rationale for selecting ridership objectives as the top priority. Ridership objectives correspond to benefits to transit users, an important consideration given the fact that transit remains a community service rendered in a quasi-governmental setting. Benefits to transit users are usually dependent on frequent usage, that is, passenger trips or passenger mileage. If the intent of the transit property is to maximize the benefits to transit users, and fulfilling its community service orientation, then the maximization of ridership should become the objective of highest priority.

---

[1]Gordon J. Fielding, et. al. (1984). p. 43.

[2]See the statement in Public Technology Inc. Proceedings of the First National Conference on Transit Performance. Washington, D.C. 1978.

Focusing on the attraction of the most riders as the highest priority objective doesn't translate into abandoning other efficiency and effectiveness objectives. Indeed, it is still necessary to set performance targets for each of these objectives and to measure progress towards their achievement. However, pursuing these objectives is secondary to the overall goal of maximizing ridership. If there are several sets of ridership figures compatible with targets on efficiency and effectiveness objectives, then policies for attaining the largest ridership figure (whether in terms of passenger trips or passenger-miles) compatible with the lower hierarchy objectives should be pursued.

## IDENTIFICATION OF CONSTRAINTS

Once the objectives are identified and the highest priority objective selected among the set of overall objectives, the next task of the corporate planner is to identify the most important constraints hampering the achievement of the objectives.

In these days of budget scarcity, by far the most important constraint is the level of subsidy support available from external sources -- Federal, state, and local governments. Obviously, policies for maximizing ridership -- the avowed social goal of increasing benefits to users -- such as fare reductions and level of service improvements, are constrained by the subsidy funds available from external sources. Other important constraints are noted in Table 2-2 and are discussed next.

The number of vehicles and other equipment may also constitute short-run constraints in achieving objectives. For example, some properties are reluctant to undertake improvements in peak hour levels of service because, in the short run, they lack the bus capacity to do so. Collective bargaining agreements must also be taken into account as constraints. A transit property may also find itself with a constraint on the number of drivers or even skilled mechanics, constraints which, while not usually binding in the long-run, may affect the feasibility of short-run policies.

The constraints need to be identified so that the design of performance criteria, which is the subject of the next chapter, reflects efficient utilization of the constrained factors -- whether funds, vehicles, labor, or other.

Table 2-2

PARTIAL LIST OF CONSTRAINTS

Financial/Operating

- Federal, state and subsidy support
- Debt capacity
- Minimum level of service specifications
- Vehicle fleet
- Drivers
- Skilled maintenance personnel
- Collective bargaining agreements

Social/Political

- Vehicle accessibility requirements
- Special fares for elderly and handicapped
- Special demand responsive service for elderly and handicapped
- Service coverage to new areas
- Labor protection agreements
- Buy America provisions
- Clean Air Act program

## Social and Political Constraints

The social orientation of transit service and the quasi-public nature of the transit boards translates into a set of social and political constraints that need to be considered. Critics of the current state of transit planning have argued that the transit industry has been assigned an array of social goals which sometimes conflict with the overall goals of transit.

Examples of the social constraints include the accessibility of service provisions (Section 504 of the Rehabilitation Act of 1978, as amended), the provisions for reduced fares for the elderly and handicapped (Section 16 of the Urban Mass Transportation Act of 1964, as amended), and the use of transit service to accomplish environmental objectives of the Clean Air Act. Other social and political constraints include the Buy America provisions and the labor protection provisions which may affect the productivity objectives of the transit company.

## RIDERSHIP MAXIMIZATION: AN EXAMPLE FROM ABROAD

The focus on ridership maximization as the highest priority objective of a transit corporation also characterizes some of the foreign experience, particularly that of London Transport. The British Transport (London) Act of 1969 initially specified London Transport's general duty to be "with due regard to efficiency, economy, and safety of operation, to provide or secure the provision of such public transport as best meets the needs for the time being of Greater London, while meeting its financial obligations."[1]

But this general statement of goals was found to be too general and vague to permit concise enunciation of corporate policies. A later modification of London Transport's goals in 1972 required the corporation to break even every year on revenue accounts, that is, on the income statements of the corporation.

Initial efforts to articulate a general policy for London Transport convinced the London Transport Board and Executive of the need for a "Corporate Aim" that would be simple and easy to understand by all levels of staff so as to contribute to its pursuit. Since London Transport does not operate with a commercial profit-maximizing objective, it became necessary to articulate objectives in a "Corporate Aim Statement" to develop a basis for deciding how to allocate scarce resources.

It was decided that the Corporate Aim would be clearly defined, quantifiable, objectively measurable, easy to understand, and open-ended. The open-ended features of the Corporate Aim needs some explanation. The London Transport planners felt that the development of fixed targets for achievement allows an organization to be satisfied with the status quo just because some target standard has been achieved. Instead, they proposed that the Corporate Aim be open-ended, that is, include a maximizing open-ended objective.

Development of the Corporate Aim focused on the fact that in public transportation undertakings, the success of the operations is not measured in terms of profits, but in terms of the community benefits it provides. In addition, it was thought that financial result should not be the objective of a public transit corporation, but that financial result should be considered as a constraint on the achievement of maximum community benefits.

---

[1] Quoted in: London Transport Executive. "London Transport's Corporate Aim." London, England 1977 (Mimeo).

The London Transport planners devised an aim that encouraged the search for community benefits while achieving the desired financial result. Given that benefits are a function of the magnitude of ridership -- passenger miles of user travel -- the Corporate Aim, adopted in 1975, specified the following objective:

> "to sell as much passenger-mileage as possible while meeting the current (mainly financial) constraints."[1]

This statement of objectives, called the Corporate Aim of London Transport, is also referred to as the passenger mile maximization program. The Corporate Aim, which identifies a constraint: available funds, and an objective: maximum passenger miles, has been translated into a decision criteria or performance standard of "passenger miles per £ of cost (or revenue loss)." This performance standard guides operating and investment proposals of different departments at London Transport. The performance criteria of passenger miles per £ of cost, labelled the "passmark" by the London Transport planners, has taken a role in transit service and fares evaluations and in the development of capital budgets similar to the role played by profit measurement/rate of return computations in conventional businesses. Translations of corporate objectives into performance criteria are explained in detail in Chapter 3.

## ADOPTING TRANSIT OBJECTIVES

At the outset it should be noted that the selection and adoption of objectives must be tailored to the situation in each transit property. A case in question concerns citizen involvement in the formulation and adoption of the statement of objectives. Obviously the strategy followed in the involvement of citizens, with regard to adopting objectives for transit, should depend on the previous experience and unique local characteristics.

Actors involved in adopting a formal statement of objectives for the transit corporation involve the Board of Directors, the General Manager and the Planning Department staff. Citizen groups may also be involved as discussed earlier. At the risk of overspecifying the process for adopting objectives, the following stages are usually present.

---

[1]London Transport Executive Business Planning Office. "London Transport Corporate Aim Explained." London, England, 1975 (mimeo).

Stage I -- List of Objectives

A list of transit objectives is prepared by the planning staff for the General Manager, who in turn presents it to the Board explaining trade-offs and interactions between the different objectives. The Transit Board discussions (over 1 or 2 sessions) on the priority of objectives are summarized to guide further development.

Stage II -- Draft Objectives and Criteria

At this stage, the General Manager using the Board's inputs, drafts a prioritized list of objectives and recommends performance criteria for measuring the achievement of these objectives. The Board reviews the objectives and discusses the performance criteria levels recommended by the General Manager.

Stage III -- Reporting System on Achievement of Objectives

Next, a reporting system for monitoring progress is proposed to the Board by the General Manager. The frequency of reporting may be quarterly, semi-annually, or annually. Most properties conduct semi-annual evaluations, but this may be too long a period in some instances.

Stage IV -- Draft Statement on Objectives

Based on discussions with the Board, the planning staff -- under the supervision of the General Manager -- refines the prioritized list of objectives and performance criteria. A draft statement is proposed.

Stage V -- Citizen Involvement

At this stage, depending on the local situation, the citizens may be involved through a public hearing before final adoption by the Board. It is also possible to form a working citizens advisory committee to assist in the initial stages.

Stage VI -- Final Statement on Objectives

A final statement on objectives is formally approved by the Board, along with schedules for reports on the progress toward achievement of the objectives.

It is important to note that the main function of the corporate statement on transit objectives is for internal managerial evaluation purposes.

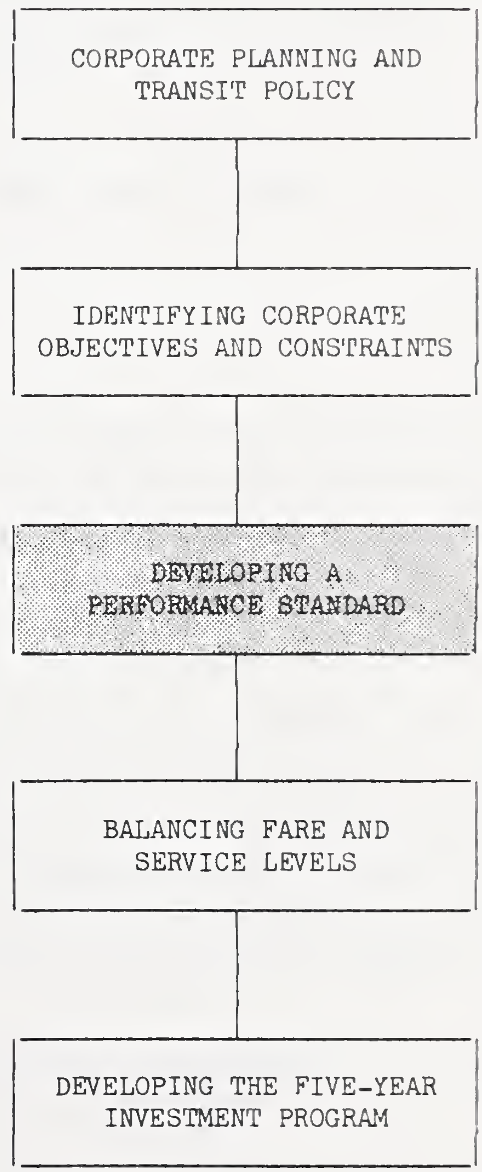
## ADVANTAGES FROM ADOPTING A STATEMENT ON CORPORATE OBJECTIVES

The setting of goals and objectives and their eventual translation into performance criteria provides the basis for evaluating the progress and eventual success of the transit property in achieving its prioritized objectives.

Numerous advantages flow from adopting a corporate objective. Board members become aware of overall objectives and can supervise the General Managers more effectively. Transit managers -- at all levels -- can make short-run operating decisions (within one year) which are consistent with the stated objectives. An internal evaluation system which measures progress towards meeting objectives becomes a by-product of the exercise of developing statements on goals and objectives. Finally, the General Manager and the Board are able to analyze trade-offs between service implications and costs incidental to each objective.

The next chapter continues the development of the Corporate Planning Approach by discussing the development of performance standards.

# 3


CORPORATE PLANNING AND TRANSIT POLICY
IDENTIFYING CORPORATE OBJECTIVES AND CONSTRAINTS
DEVELOPING A PERFORMANCE STANDARD
BALANCING FARE AND SERVICE LEVELS
DEVELOPING THE FIVE-YEAR INVESTMENT PROGRAM

# 3

## DEVELOPING A PERFORMANCE STANDARD: THE PASSMARK CONCEPT

After the corporate goal and objectives are selected, and the major constraints noted and quantified, the next step in the corporate planning approach is to determine the appropriate performance standard for the relevant objective.

### GENERAL APPROACHES

As a general rule, the performance standard serves two purposes: 1) it provides for measurement of progress towards achievement of objectives, and 2) it provides decision rules which, if followed, lead to the achievement of the corporate objective. The performance standard is usually designed by comparing the objective being measured to the major constraint on its achievement. This comparison, usually in the form of a ratio, may be expressed as follows:

$$\text{(3.1)} \qquad \begin{array}{c}\text{Performance}\\\text{Standard}\end{array} \simeq \frac{\text{Corporate Objective Measurement}}{\text{Constraint Measurement}}$$

The performance standard, or ratio of objective measure achieved per unit of constraint, provides a decision rule guiding managers' actions and policies towards efficient use of the constrained resources.

A Corporate Example

Assume a private commercial corporation's objective of maximizing profits or net income subject to a constraint on the capital resources at hand plus those that can be raised in external capital markets. In this case, the appropriate performance standard becomes

$$\frac{\text{Present Value of Net Income}}{\text{Present Value of Capital Investment}} \tag{3.2}$$

This performance standard is also applicable to a corporation whose objective is to maximize the market value of its stockholders equity, since the market value of the stockholders' equity is the product of the price/earnings ratio times the net earnings. Indeed, the performance standard shown in (3.2) refers to the internal rate of return of the corporation, the most common performance criteria used for capital budgeting purposes in the corporate business world. The internal rate of return is the rate which equates the present value of net income returns to the present value of the capital investment.

Internal rates of return are calculated in the business world to measure the relative attractiveness of capital investment projects, attractiveness in terms of contributing to the corporation's objective of maximum market value of the firm. Projects are ranked in descending order in terms of their internal rates of return and those projects with the highest rates of return are chosen until the investment funds are exhausted. In the absence of constraints on the availability of investment funds, the marginal or cut-off rate of return is set equal to the market rate of interest or the marginal cost of funds and projects that earn rates of return below the cut-off or marginal rate are not funded.

A Transit Example

The same analytical framework could be utilized to develop a performance standard for transit properties. Suppose, for example, that the transit corporation's objective is to increase its net revenues and that its major short run constraint is the bus fleet availability, the performance standard applicable to this objective and constraint is:

$$(3.3) \qquad \text{Performance Standard} \simeq \frac{\text{Revenue - Cost}}{\text{Number of Buses}}$$

Other examples of performance standards and the objectives to which they correspond were presented earlier in Chapter 2. However, this report focuses on the development of a performance standard applicable to the highest priority objective (i.e., the ridership maximization objective); which is recommended by APTA and is the focus of transit corporate planning efforts abroad.

PERFORMANCE CRITERIA FOR HIGHEST PRIORITY OBJECTIVE

The determination of the highest priority objective of a transit corporation was discussed in Chapter 2. The objective of maximum possible ridership given financial constraints on the subsidy level was deemed to be the highest priority objective because of its close relationship to the concept of transit user and community benefits.[1]

Implementation of a maximum ridership objective entails defining this objective as maximum passenger miles, since the benefits from ridership are related to the trip length; that is, the longer the trip length the greater the benefits, holding the purpose of the trip constant. However, a practical problem in American settings makes it difficult to use passenger mile maximization as the highest priority transit objective. The problem is that passenger-mile data are generally unavailable, or if available, are of dubious quality in the management information systems used by American properties. Because of this practical problem, it becomes necessary to adopt a second best measure of ridership maximization, such as maximizing passenger trips, as the quantifiable objective of highest priority for an American transit property.

Development of a performance standard applicable to the highest priority objective of maximizing passenger trips also requires identification of the major constraint. In this case, the subsidy level (and the resulting availability of total dollars for transit) appears to be the most important constraint facing American transit properties. The initial step in the specification of

[1]The correspondence of maximum ridership and maximum community benefits is close if it is assumed that transit markets are similar in their ridership responsiveness to fares. See: D.J. Wagon. "Resource Allocation for Bus Service Planning." London Transport Executive. Operational Research Report R221. London, England, July 1976, p. A-2.

the subsidy level constraint is for the governmental organizations providing external subsidy support to ascertain the optimal level of support, or at least that the benefits from the subsidy exceed its costs. This procedure entails estimating benefits from reducing externalities such as traffic congestion, accidents, and air pollution emissions, and the revenue impacts of changes in the subsidy level. For the moment let us assume that the subsidy level constraint is appropriate and that benefits from the transit subsidy exceed its costs.

Given the objective of providing the maximum passenger trips possible under the subsidy level constraint, the performance standard may be expressed as the ratio shown in Table 3-1.

Table 3-1

PERFORMANCE CRITERIA FOR THE HIGHEST PRIORITY OBJECTIVE

| | |
|---|---|
| Highest Priority Objective | Provide maximum passenger trips (related to goal of maximum community and user benefits) |
| Major Constraint | Level of subsidy support from Federal, state, and local governments (assuming benefits from transit exceed the cost of the subsidy) |
| Performance Standard | Passenger trips per dollar of subsidy support required (or passenger trips per dollar of net costs) |

The similarities of the transit performance standard and the internal rate of return (see Equation 3.2) used in the corporate world are many. Both concepts have dollar costs in the denominator and result from maximizing benefit-related concepts. Differences occur in the numerator with the internal rate of return using the present value of net income returns while the transit performance criteria uses passenger trips as a proxy for user and community benefits. More on the relationships between the performance criteria and the internal rate of return is presented later in this chapter.

## Simple Applications

The performance standard of "passenger trips per dollar subsidy" (or per dollar of net costs) becomes the single yardstick which can be used for evaluating the appropriateness of both transit operating policies and capital projects. That is, the consequences of every policy and capital project may be evaluated in terms of its impact on a) passenger trips or ridership, and b) finance or subsidy requirements. Projects and policies can have positive or negative effects on passenger trips or on the financial subsidy requirements. Projects that increase both passenger trips and gain funds either through revenue increases or cost decreases should clearly be undertaken. In the same vein, policies and projects which increase passenger trips at no extra cost, or result in cost reductions but have no effect on passenger trips, should be undertaken. The hard policy evaluation questions refer to policies which gain revenues but result in passenger-trip losses (such as fare increases) and policies which increase passenger trips but at extra costs (such as service improvements and some capital projects). Evaluations of these policies and projects require a trade-off between passenger trips and their net revenue impacts or subsidy requirements; these analyses require the quantification of the performance standard.

Essentially, the performance standard is needed to make decisions between projects or policies which gain passenger trips but lose money or increase costs and those which gain money or reduce costs but lose passenger trips. Priority will be given to those projects and policies which gain the most passenger trips per dollar loss or which lose the least passenger trips per dollar gained.

Revenue and capital projects may be analyzed in terms of "passenger trips per dollar of net costs" and contrasted with each other, provided that the capital projects' impacts are consistently measured either in terms of the ratios of two net present values or annual equivalent figures. In this report annualized costs, and average annual passenger trip impacts, are extensively used.[1]

---

[1]Later in this section, the process followed in annualizing capital costs is explained in detail.

## QUANTIFICATION OF THE PERFORMANCE STANDARD

The performance standard, defined in terms of "passenger trips per dollar of net costs" may be referred to as the return standard, the performance yardstick, or simply the passmark.[1] Determination of the level of the passmark or performance standard requires estimating the effect of each policy on both passenger trips and subsidy requirements and selecting the best projects until the subsidy constraint is met. The "passenger trips per dollar of net costs" corresponding to the marginal project/policy becomes the passmark level. That is, the performance standard or passmark level is the one that meets the budget constraint, so that the passmark value varies according to the budget constraint levels. However, there is a lower limit to the range of possible passmark values. This lower limit is determined by the alternative of raising or lowering fares depending on the circumstance. Several analytical steps are involved in determining the passmark level, the first of these steps is specifying the lower limit of the passmark.

### Lower Limit of Performance Standard

Estimating the quantitative level of the performance standard begins by determining its lower limit. The lower limit of the passmark or performance standard is given by the option of changing fares. After all, if there is a revenue shortfall there is always the option of increasing fares or, alternatively, of reducing fares if the external subsidy level is increased.

If the only major constraint is the budgetary or subsidy level constraint, the lower limit of the passmark is given by the passenger trip loss from a small fare increase (or gained from a small fare decrease). This estimate of the lower limit of the passmark in terms of marginal changes in fares and passenger trips can be expressed as the absolute value of the ratio of the small change in passenger trips to the small change in fare revenues:

$$\text{Passmark} = \left| \frac{\text{Small Change in Passenger Trips}}{\text{Small Change in Fare Revenues}} \right| ; \tag{3.4}$$

where $|\ |$ denotes absolute values.

[1]The reader should note that the passmark used by London Transport is only slightly different, since it is defined in terms of passenger miles per pound sterling (£). See D.A. Quarmby. "Investment Planning in London Transport Using Non-Financial Criteria-Part I." Journal of Enterprise Management, Vol. I, 1978, p. 37.

The definition of the lower limit of the passmark indicates that the passmark is equal to the inverse of the marginal revenue (or change in fare revenues due to small changes in passenger trips). This relationship is mathematically proven in Table 3-2. Thus, the lower limit of the passmark may then be estimated as function of the fare elasticity ( $\mathcal{E}_f$) and the fare level (f) as follows:

$$(3.5) \qquad \text{Passmark} = \left| \frac{1}{MR} \right| = \left| \frac{1}{f\left(1 + \frac{1}{\mathcal{E}_f}\right)} \right|$$

where:

MR = marginal revenue

$\mathcal{E}_f$ = average fare per passenger

f = fare elasticity, and

$|\;|$ denotes absolute values

The passmark is estimated in an iterative procedure whose starting point is the determination of the ridership impacts of small fare changes. Suppose that capital projects that gain passenger ridership at a certain cost are contemplated. Clearly an alternative to these projects may be to save their cost and offer fare reductions of an equal amount. Therefore, the fare reduction option becomes one of the alternatives or opportunity costs of spending the money budgeted for capital projects. Another similar view is to consider the effects of raising fares to generate the funds required for the financing of the capital projects. In any event, the fare change option provides the decision-maker with a benchmark regarding the lower limit of the passmark.

An example of the initial calculation of the passmark's level is provided next. If, for example, the fare elasticity is -0.3 and the average fare per passenger is \$0.56, then the lower limit of the passmark is given by:

$$(3.6) \qquad \text{Passmark} = \left| \frac{1}{0.56\left[1 + \frac{1}{(-0.3)}\right]} \right| = \left| \frac{1}{(-1.3067)} \right| = 0.765 \text{ passenger trips per dollar of net cost}$$

Table 3-2

INITIAL DETERMINATION OF THE PASSMARK

1. The lower limit of the passmark, corresponding to the fare option is given by:

(a) $$\text{Passmark} = \left| \frac{\text{change in passenger trips}}{\text{change in fare revenues}} \right| = \left| \frac{\Delta q}{\Delta(f.q)} \right|$$

where:

$\Delta q$ = marginal change in passenger trips

$\Delta(f.q)$ = marginal change in fare revenues

$f$ = average fare per passenger

$q$ = passenger trips, and

$| \;\; |$ denotes absolute values

But marginal revenue (MR) is defined as:

(b) $$\frac{\Delta(f.q)}{\Delta q} = MR$$

thus,

(c) $$\text{Passmark} = \left| \frac{1}{MR} \right|$$

However, the formula for the marginal revenue in terms of fares and fare elasticities is given by :

(d) $$MR = f\left(1 + \frac{1}{\mathcal{E}_f}\right)$$

where

$MR$ = marginal revenue

$f$ = average fare per passenger

$\mathcal{E}_f$ = fare elasticity

The lower limit of the passmark may then be estimated as function of the fare elasticity ( $\mathcal{E}_f$) and the fare level (f) as follows:

(e) $$\text{Passmark} = \left| \frac{1}{f\left(1 + \frac{1}{\mathcal{E}_f}\right)} \right|$$

The meaning of the passmark is as follows: projects and policies should be undertaken if the passenger trips gained by the project or policy per dollar of net cost exceeds the passmark level, or if the passenger trips lost per dollar gained is less than the passmark. The policies and projects that pass this screening process are now candidates for further evaluation. Those that do not pass this simple test are termed "unfeasible" in terms of maximizing ridership, since they are inferior to simple fare policies for accomplishing the transit authority's corporate objective.

## Reflecting Political Considerations

In the real world, transit decisions on both fares and services are affected by political considerations -- considerations that clearly have to be taken into account in developing performance standards, such as the level of the passmark.

Suppose higher fares are politically unacceptable and the politically acceptable fare level is lower than the current fare level. In this case, the lower limit of the passmark may be evaluated at the lower, but politically acceptable fare level. The passmark would then be estimated to reflect the political views about appropriate fare levels. For example, if the politically acceptable fare level is $0.40, the passmark may be re-estimated as follows:

$$(3.7) \quad \text{Passmark} = \left| \frac{1}{0.40\left[1 + \frac{1}{(-0.3)}\right]} \right| = 1.07 \text{ passenger trips per dollar of net costs}$$

assuming that fare elasticities remain the same at these two fare levels.

Lowering the fares to reflect political considerations results in a higher passmark level and a more stringent requirement for the capital projects, which must now generate higher levels of ridership per unit of costs than before.

## DETERMINATION OF NET RETURNS AND RANKINGS OF PROJECTS AND POLICIES

The determination of the passmark's lower limit provides the transit planner with the tool for trading-off passenger trip impacts and dollar impacts or net revenues. The passmark value enables us to "value" passenger trip impacts into dollars. The next step is to use the lower limit of the passmark to convert passenger trip impacts for each policy or project into dollar equivalents.

This value essentially represents the gross return on the project. However, the determination of net returns requires consideration of revenues and annualized costs adjusted to reflect the presence of Federal subsidies. Methods for annualizing capital costs and for adjusting the effects of Federal subsidy policies are discussed in this section. The following expression may be used to estimate net returns:[1]

$$(3.8)\ \text{Net Returns} = \left(\frac{\text{Passenger Trips}}{\text{Passmark}}\right) + \left(\begin{matrix}\text{Adjusted}\\ \text{Revenues}\end{matrix}\right) - \left(\begin{matrix}\text{Adjusted}\\ \text{Annualized Costs}\end{matrix}\right)$$

The lower limit of the passmark value is introduced into expression (3.8) to compute the net returns for each project or policy under consideration. Projects or policies whose net returns are negative may be eliminated from consideration, since they are inferior to simple fare adjustment policies. Revenues and annualized costs are adjusted to reflect the effect of Federal subsidy policies as explained in Equation (3.12).

Projects whose net returns are positive are ranked in terms of ratios of returns to costs. Two possible situations arise. For projects which result in decreases in net revenues while gaining passenger trips, the return ratio is given by:

$$(3.9)\ \text{Return Ratio} = \left(\frac{\text{Passenger Trips}}{\text{Passmark}}\right) \div \left[\left(\begin{matrix}\text{Adjusted}\\ \text{Revenues}\end{matrix}\right) - \left(\begin{matrix}\text{Adjusted}\\ \text{Annualized Costs}\end{matrix}\right)\right]$$

In the case of projects or policies which result in gains in net revenues while incurring losses in passenger trips, the return ratio is given by:

$$(3.10)\ \text{Return Ratio} = \left[\left(\begin{matrix}\text{Adjusted}\\ \text{Revenues}\end{matrix}\right) - \left(\begin{matrix}\text{Adjusted}\\ \text{Annualized Costs}\end{matrix}\right)\right] \div \left(\frac{\text{Passenger Trips}}{\text{Passmark}}\right)$$

---

[1]London Transport's planning methodology labels the net returns as "Achievement" if the returns are positive and as "Detriment" if the net returns are negative. See M. Whitley "Optimizing Public Transport Performance - The London Method" in Symposium on Integrating Public Transport, Newcastle University, 1977.

Again using the lower limit of the passmark, each project and policy return ratio is estimated and projects are ranked in descending order of return ratios. Projects and policies are then selected in descending order of return ratios until the budget or subsidy constraint is met. The "passenger trips per dollar of net cost" corresponding to the marginal project provides the quantitative value of the performance standard or passmark.[1]

Annualizing Capital Costs and Ridership Impacts

As referred to earlier in this chapter, ridership impacts and cost impacts have to be consistently measured for comparative purposes either in terms of discounted present values or using annualized equivalents. The analysis followed in this report uses annualized equivalent concepts.

In the case of ridership and revenues, annualized concepts should refer to the average annual figures during the service life of the equipment. However, given the difficulties of estimating 20-30 year ridership impacts for some investments (i.e., stations, garages, etc.) the analysis of these impacts are usually restricted to the immediate 5-10 year period after construction, a period which should at the minimum correspond to the capital budget period. That is, if the practice is to develop a five year investment program, then the ridership impacts should be estimated at least to correspond to the five years of the investment program.

Capital costs are annualized using capital recovery factors. The formula used for estimating these annualization factors is:

---

[1]This iterative procedure to calculate the passmark is analogous to the standard mathematical procedure of constrained maximization via the Lagrange multiplier technique. In this case, the objective function (Z) to be maximized is defined as:

$$Z = \text{Passenger Trips} + \lambda(\text{Revenues} + \text{Subsidy} - \text{Costs})$$

where passenger trips, revenues and costs are functions of fares, service levels, and capital investments, while the subsidy level is exogenously determined.

Values of $\lambda$, fares and service levels are sought to maximize the objective function Z. The variable $\lambda$ denotes the rate at which passenger trips and money are traded off. Its optimum value corresponds to the passmark and is defined as the passenger trips that an additional dollar of subsidy would generate. See: C.A. Nash. "Management Objectives, Fares and Service Levels in Bus Transport". Journal of Transport Economics and Policy, January 1978, pp. 70-85.

$$\text{(3.11)} \qquad CRF = \left[ \frac{i(1 + i)^{n}}{(1 + i)^{n} - 1} \right]$$

where:

CRF = capital recovery factor corresponding to interest rate i and service life n

i = local government borrowing rate

n = economic or service life of equipment or structure

The capital recovery factor when multiplied by the total initial cost of the project less any residual value at the end of its service life results in an annual uniform series covering annual amortization and interest charges on the equipment or structure in question. For example, consider a project consisting of the purchase of 20 articulated buses at $250,000 apiece, at a total of $5,000,000, with a service life of 12 years and a residual value at the end of that period equal to ten percent of the original cost, or $500,000. At a local government borrowing rate of ten percent, the CRF is calculated to be:

$$CRF = \left[ \frac{.10\ (1 + .10)^{12}}{(1 + .10)^{12} - 1} \right] = .146763$$

The annualized capital cost is therefore:

Annualized Capital Costs = CRF (Capital Cost - Residual Value)
Annualized Capital Costs = .146763 ($5,000,000 - $500,000)
Annualized Capital Costs = .146763 ($4,500,000)
Annualized Capital Costs = $660,435

The use of the capital recovery factors enables the decision-makers to compare capital investments of different longevity and to simplify comparisons with average annual returns from the capital projects. Placing all costs and returns on the same basis is indispensable in performing project comparisons.

## Adjustments for Federal Operating and Capital Subsidies

The previous analysis of the estimation of the passmark's value and net returns must take into account the effect of Federal subsidies.[1] Whenever Federal formulas for subsidies (either operating or capital) are not available or whenever the transit property is operating beyond caps on Federal subsidies, no corrections on the computations of the passmark value are required to reflect the differential effects of different subsidy rates for operating and capital subsidies.

If the transit company is operating within the caps on operating and capital subsidies, it becomes necessary to adjust the expressions presented earlier for the estimation of net returns and return ratios to reflect the differential treatment of formula-based Federal operating and capital subsidies. Indeed, the presence of different subsidy rates for operating versus capital expenses introduces distortions on the allocation of resources between policies affecting operating revenues and expenses and capital investment projects. The presence of 80 percent Federal capital subsidies makes the cost of capital projects less expensive when contrasted to policies and projects that have effects on operating budgets.

If the transit company is operating within the range of availability of Federal operating subsidies, the lower limit of the passmark is estimated by:

$$(3.13)\quad \text{PASSMARK} \; + \; \left| \frac{1}{(1 - S_o)(MR)} \right| \; + \; \left| \frac{1}{(1 - S_o)\,(f)\left(1 + \dfrac{1}{\mathcal{E}_f}\right)} \right|$$

where:

$S_o$ = subsidy rate for Federal operating subsidies

MR = marginal revenue

f = fare level

$\mathcal{E}_f$ = corresponding fare elasticity of demand

$| \; |$ denotes absolute values

[1]The effect of Federal subsidies on net return computations are comparable to the corporate finance treatment of tax-deductible interest charges.

The effect of operating within Federal operating subsidies is to increase the passmark's lower limit value, since the cost of revenue shortfalls are less to the transit company due to the Federal subsidy.

Similarly, revenues, operating expenses and capital costs are adjusted to reflect the Federal formulas for operating and capital subsidies as follows:

$$\text{Adjusted Revenues} = (1 - S_o)\ (\text{Revenues})$$

(3.14)

$$\text{Adjusted Operating Costs} = (1 - S_o)\ (\text{Operating Costs})$$

$$\text{Adjusted Annualized Capital Costs} = (1 - S_c)\ (\text{Annualized Capital Costs})$$

$$\text{Adjusted Annualized Costs} = (1 - S_o)\ (\text{Operating Costs}) + \\ + (1 - S_c)\ (\text{Annualized Capital Costs})$$

where:

$S_o$ = Federal operating subsidy rate

$S_c$ = Federal capital subsidy rate

These adjusted revenues and costs are then used in Equations (3.8), (3.9), and (3.10). If the transit company is operating in excess of the Federal cap on operating and capital subsidies, then

$$S_o = 0$$
$$S_c = 0$$

for the subsidy requirements exceeding the Federal cap, and no adjustments are necessary to the financial return computations.

The modifications and adjustments to the passmark's lower limit value, and to revenues and costs only come into use when evaluating projects and policies for which formula-based subsidies will be available, that is, when the transit system's budget is below the constrainted Federal subsidies.

## AN EXAMPLE

An example of the determination of the passmark level for a hypothetical transit property is presented next.[1] The site for this example is a hypothetical Midwestern City, Pricing (Missouri) with a population of 700,000 inhabitants. Since 1970, public transportation in Pricing has been provided by USA Transit. Some of the statistics on USA Transit's operations are shown in Table 3-3.

---

[1]This hypothetical transit property has been used as an example before. See: Ecosometrics, Inc. A Manual for Planning and Implementing a Fare Change, prepared for the Urban Mass Transportation Administration, Office of Service and Methods Demonstration, August, 1984, p. A-2.

Table 3-3

USA TRANSIT FACTS - HYPOTHETICAL[a]

| | 1983 | Preliminary Projections - 1984 |
|---|---|---|
| **Operating Statistics** | | |
| Service Area Population (thousands) | 700 | 700 |
| Annual Ridership | 14,223,214 | 14,436,562 |
| Fleet Size | 240 | 240 |
| Employees | 450 | 445 |
| Routes | 66 | 66 |
| Annual Bus Mileage (millions) | 6.0 | 6.0 |
| Average Weekday Ridership (thousands) | 50 | 51 |
| Average Weekday Revenue | 28,145 | 28,567 |
| Operating Ratio | 0.50 | 0.49 |
| **Financial Statistics** | | |
| Farebox Revenue | $ 7,965,000 | $ 8,084,474 |
| Other Revenue | 183,195 | 183,300 |
| | 8,148,195 | 8,267,774 |
| Less: Operating Expenses | 15,930,000 | 16,740,000 |
| Debt Service (Interest and Amortization of Capital Expenses) | $ 1,200,000 | $1,593,900 |
| Subsidy Requirements | 8,981,805 | 10,066,126 |
| Federal | 4,301,100 | 4,991,521 |
| State | 3,714,315 | 3,912,815 |
| Local Subsidy | 966,390 | 1,161,790 |
| Cost Per Passenger Trip | $1.12 | $1.15 |
| Fare Revenue Per Passenger Trip | $0.56 | $0.56 |
| Operating Cost Per Bus Mile | $2.66 | $2.79 |
| Fare Revenue Per Bus Mile | $1.33 | $1.347 |

[a]Previous to the cut of $2.2 million in Federal operating subsidies.

Source: Ecosometrics Inc. A Manual for Planning and Implementing a Fare Change. Prepared for the Office of Service and Methods Demonstration. Urban Mass Transportation Administration. Bethesda, Maryland. August 1984, p. A-2.

USA Transit projects a requirement of $10.07 million in subsidies for 1984 to finance the operating deficit and the debt service of capital projects, including five new projects. The new capital budget projects include a new garage, articulated and conventional bus acquisition and replacement, passenger shelters and the initial stages of a passenger information aids program. However, after the financial projections are completed, USA Transit is informed that because of a cut in Federal operating subsidies, the Federal commitment for 1984 can only be $2.79 million, requiring a cut in operating subsidies of $2.2 million for 1984. The subsidy shortfall of $2.2 million must be made up by abandoning some of the capital improvement projects and by considering a combination of fare increases and service reductions. The UMTA commitment for capital subsidies is for $15 million in 1984, and $40 million for the five-year period 1984-1988. This hypothetical information will be used in this example to develop the level of the passmark or performance standard for USA Transit under these stringent budget conditions.

## Listing of Projects and Their Impacts

The first step is to estimate the impact of the policies and projects on passenger trips, revenues, and costs. In accordance with the Federal subsidy scenarios, USA Transit is within the cap on Federal capital subsidies for 1984, but its need for Federal operating assistance exceeds the UMTA ceiling on operating subsidies. These scenarios translate into the need for adjusting the capital costs to take into account the Federal capital subsidy rate. However, no adjustments are needed to reflect the influence of operating subsidy rates, since USA Transit is exceeding the UMTA ceiling on operating assistance for 1984. Using standard assumptions about demand elasticities presented elsewhere,[1] Table 3-4 presents estimates of the effects of seven different policies and projects affecting subsidy requirements and ridership. In Table 3-4, the adjusted annualized capital costs represent the annualization of the 20 percent local share of capital expenses.

[1]Ecosometrics Inc. Patronage Impacts of Changes in Transit Fares and Services. Prepared for the Urban Mass Transportation Administration's Office of Service and Methods Demonstration. Bethesda, Maryland. September 1980.

Table 3-4: USA TRANSIT -- INVENTORY OF ALTERNATIVE POLICIES AND CAPITAL PROJECTS -- 1984

| Policy and Project Options | Passenger Trips (1) | Farebox Revenues (2) | Annualized Costs: Operating (3) | Annualized Costs: Capital (4) | Annualized Costs: Adjusted Capital[h] (5) | Adjusted Net Operating Revenues (6) = (2)-(3) | Adjusted Net Annualized Costs (7) = (5)-(6) | Passenger Trips Per Dollar of Adjusted Net Annualized Costs (8)=\|(1)\|÷\|(7)\| |
|---|---|---|---|---|---|---|---|---|
| Regular Bus Replacement Program[a] | 0 | 0 | $- 330,000 | $+ 792,520 | $+158,504 | $+ 330,000 | $- 171,496 | Not Defined |
| Fare Increase (+10%)[b] | -433,097 | $+541,660 | Negl. | Negl. | Negl. | + 541,660 | - 541,660 | 0.800 |
| Service Cuts (-10% change in Bus Miles)[c] | -721,828 | -404,224 | -1,674,000 | 0 | 0 | +1,269,776 | -1,269,776 | 0.568 |
| Passenger Information Aids Projects[d] | + 72,183 | +40,422 | + 100,000 | 0 | 0 | - 59,578 | + 59,578 | 1.212 |
| New Garage Project[e] | +144,366 | +80,845 | 0 | +1,909,420 | +381,884 | + 80,845 | + 301,039 | 0.480 |
| Articulated Bus Purchase Program (20 buses)[f] | +170,678 | +95,580 | + 10,000 | + 660,435 | +132,087 | + 85,580 | + 46,507 | 3.670 |
| Passenger Shelter Program[g] | + 29,991 | +16,795 | 0 | + 275,000 | + 55,000 | + 16,795 | + 38,205 | 0.785 |

Notes

[a]Covers normal replacement of 40 buses at $150,000 each. The capital costs are amortized over 12 years at ten percent discount rates and ten percent residual values using capital recovery factors.

[b]Assumes a -0.3 fare elasticity of demand.

[c]Assumes a +0.5 bus miles elasticity.

[d]Assumes a 0.5 percent increase in passenger trips due to the distribution of schedules and passenger information leaflets.

[e]Covers the construction of a $20 million garage amortized over 30 years at 10 percent discount rate and ten percent residual values using capital recovery factors. The new garage would yield no net operating cost savings. The estimate of passenger response assumes a 2.5 percent increase in on-time arrivals and a response elasticity of +0.4. For simplification purposes, it is assumed that the ridership gains continue over the life of the project.

[f]Covers the purchase of 20 articulated buses at $250,000 each. The capital costs are amortized over 12 years at 10 discount rates and 10 percent residual values using capital recovery factors. The articulated buses are assumed to increase peak period travel by 20 percent in the 20 congested routes.

[g]Covers a $1.877 million installation program. The costs have been amortized over 10 years with 10 percent residual value. The increase in ridership is assumed to 0.2 percent.

[h]Estimated as 20 percent of the annualized capital costs to reflect Federal capital subsidies.

## Decision Rules and Preliminary Passmark Levels

Since projects and policies can have either positive or negative effects on the transit property's financial position and on passenger trips carried, the projects can be grouped into the categories presented in Table 3-5. Applying the decision rules presented in Table 3-5, one capital project -- the regular conventional bus replacement program -- should be undertaken unconditionally. Evaluation of all the other projects require the estimation of the lower limit of the passmark or performance standard.

Assuming, from Tables 3-3 and 3-4, average fare revenues per passenger of \$0.56 and a -0.3 fare elasticity of demand, the passmark's lower limit can be estimated from Equation (3.5) as follows:

$$\text{Passmark} = \left| \frac{1}{f(1+1/\mathcal{E}_f)} \right| = \left| \frac{1}{0.56\ (1 + 1/-0.3)} \right| = 0.765$$

Using "0.765 passenger trips per dollar" as the lower limit of the passmark and the decision rules presented in Table 3-5, the following projects in Table 3-4 are deemed feasible or acceptable: the articulated bus purchase program, the passenger information aids program, the service cut program (10%), and the passenger shelter program. One capital project, the new garage project, cannot be accepted in its present design since it results in small increases in passenger trips per dollar cost. It is clearly preferable to undertake fare changes than to undertake this project. Perhaps a smaller size garage or one that results in significant operating cost savings should be contemplated. The fare increase program also fails the passmark test, suggesting that fare levels are already higher than warranted and out of balance with service levels.

## Return Ratios and Project Selection

Estimates of returns and return ratios, using Equations (3.8), (3.9) and (3.10) are estimated for all projects and policies using the passmark's lower limit of "0.765 passenger trips per dollar." This information is presented in Table 3-6 along with the project rankings. The first five projects ranked in Table 3-6 show positive net returns and return ratios exceeding 1.0. They should clearly be undertaken.

Table 3-5

CATEGORIES OF POLICIES OR PROJECTS AND APPLICABLE DECISION RULES

| | | EFFECT ON PASSENGER TRIPS | | |
|---|---|---|---|---|
| | | No Change | Increases | Decreases |
| EFFECT ON NET REVENUES | No Change | (R) | (A) | (R) |
| | Positive (decreases subsidy requirements) | (A) Regular conventional bus replacement program | (A) | ($A_1$) Fare increase (+10%) Service cut (-10%) |
| | Negative (increases subsidy requirements) | (R) | ($A_2$) Passenger information aids, New garage project, Articulated bus purchase program, Passenger shelter program | (R) |

Decision Rules:

(R) Reject unconditionally projects or policies in this category.

(A) Accept unconditionally projects or policies in this category.

($A_1$) Accept projects or policies whose "passenger trips per dollar of net cost" are less than the passmark level.

($A_2$) Accept project or policies whose "passenger trips per dollar of net cost" exceed the passmark level.

Table 3-6: USA TRANSIT -- NET RETURNS AND RETURN RATIOS OF ALTERNATIVE POLICIES AND PROJECTS -- 1984 -- PRELIMINARY

| Policy and Project Options | Passenger Trips ÷ Passmark[a] (1) | Adjusted Net Annualized[b] Costs (2) | Net Returns[c] (3) | Return Ratio[c] (4) | Adjusted Net Operating Revenues[d] (5) | Capital Costs (6) | Cumulative Operating Subsidy Requirements[e] (7) | Cumulative Capital Subsidy Requirements: Federal Share (8) | Cumulative Capital Subsidy Requirements: Local Share (9) | Passenger Trips per Dollar of Adjusted Net Annualized Costs (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| Regular Bus Replacement Program | 0 | $ -171,496 | $+171,496 | Not Defined | $+330,000 | $6,000,000 | $ -330,000 | $+4,800,000 | $+1,200,000 | Not Defined |
| Articulated Bus Purchase Program | $+233,108 | $ + 46,507 | +186,601 | 5.012 | + 85,580 | 5,000.000 | -415,580 | +8,800,000 | +2,200,000 | 3.670 |
| Passenger Information Aids Projects | + 94,357 | + 59,578 | + 34,779 | 1.584 | - 59,578 | 0 | -356,002 | +8,800,000 | +2,200,000 | 1.212 |
| Service Cuts (-10% Change in Bus Miles) | -943,566 | -1,269,776 | +326,210 | 1.345 | +1,269,776 | 0 | -1,625,778 | +8,800,000 | +2,200,000 | 0.568 |
| Passenger Shelter Program | + 39,204 | + 38,205 | + 999 | 1.026 | + 16,795 | 1,877,000 | -1,642,573 | +10,301,600 | + 2,575,400 | 0.785 |
| Fare Increase (+10%) | -566,140 | -541,660 | - 24,480 | 0.957 | + 541,660 | 0 | -2,184,233 | +10,301,600 | + 2,575,400 | 0.800 |
| New Garage Project | +188,714 | +301,039 | -112,325 | 0.627 | + 80,845 | 20,000,000 | -2,265,078 | +26,301,600 | + 6,575,400 | 0.480 |

Notes:

a. The passmark's lower limit value of |0.765| is used in these computations.

b. Estimated from Table 3-4 (Column 7).

c. Estimated from Equations (3.8), (3.9), and (3.10) using adjusted cost figures reflecting the Federal capital subsidy.

d. Estimated from Table 3.4 (Column 6).

e. No adjustment is necessary for the effect of Federal operating subsidies since USA Transit subsidy requirements exceed the UMTA ceiling on Federal operating subsidies.

However, as shown in Table 3-6, these five projects and policies generate a $1.64 million reduction in required operating subsidies, less than the $2.2 million required to meet the new operating budget. This forces the decision-makers to look for either more revenue or undertake more significant cuts in service. The revenue option through raising fares does not appear economically feasible since the passenger trips per dollar of net cost from raising fares exceeds the passmark level. This evidence suggests that the fares are too high to begin with. One solution is to implement deeper cuts in service. Table 3-7 presents a 14 1/2 percent cut in service which enables the transit property to meet the budget pressure required by the $2.2 million decrease in Federal subsidies.

Table 3-7 ranks the projects and policies in terms of their return ratio. The marginal project is the passenger shelter program, whose 0.785 passenger trips per dollar becomes the new passmark level. This final passmark level exceeds the preliminary passmark level in Equation (3.6). The passmark level is therefore determined by the passenger trips per dollar of the marginal project or the project whose acceptance exhausts the budget or subsidy constraint. The rankings presented in Table 3-7 use the final passmark level of 0.785 passenger trips per dollar of net cost.

In the end the passmark value is determined by the level of the subsidy, the distribution of feasible projects and policies, and the appropriateness and political acceptability of fare changes. The example presented in Tables 3-3 to 3-7 illustrates the interactions that take place among the factors affecting the passmark value.

## Simple Decision Rules

After determining the value of the passmark which meets the subsidy level, the following decision rules can be advanced:

a. Accept all projects which both save money and increase passenger trips.

b. Accept all projects which save money at no loss in passenger trips or gain passenger trips at no loss in net revenues.

c. Accept all projects which gain more than 0.785 passenger trips per dollar loss.

d. Accept all projects which lose fewer than 0.785 passenger trips per dollar gained.

Table 3-7: USA TRANSIT -- NET RETURNS AND RETURN RATIOS OF ALTERNATIVE POLICIES AND PROJECTS -- 1984 -- FINAL

| Policy and Project Options | Passenger Trips ÷ Pasmark[a] (1) | Adjusted Net Annualized[b] Costs (2) | Net Returns[c] (3)=(2)-(1) | Return Ratio[c] (4) | Adjusted Net Operating Revenues[d] (5) | Capital Costs (6) | Cumulative Operating Subsidy Requirements[e] (7) | Cumulative Capital Subsidy Requirements: Federal Share (8) | Cumulative Capital Subsidy Requirements: Local Share (9) | Passenger Trips per Dollar of Adjusted Net Costs (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| Regular Bus Replacement Program | 0 | $ -171,496 | $+171,496 | Not Defined | $+330,000 | $6,000,000 | $ -330,000 | $+4,800,000 | $+1,200,000 | Not Defined |
| Articulated Bus Purchase Program | $+217,424 | $ + 46,507 | +170,917 | 4.675 | + 85,580 | 5,000,000 | -415,580 | +8,800,000 | +2,200,000 | 3.670 |
| Passenger Information Aids Projects | + 91,953 | + 59,578 | + 32,375 | 1.543 | - 59,578 | 0 | -356,002 | +8,800,000 | +2,200,000 | 1.212 |
| Service Cuts (-14.5% Change in Bus Miles)[f] | -1333,313 | -1,841,175 | +507,862 | 1.381 | +1,841,175 | 0 | -2,197,177 | +8,800,000 | +2,200,000 | 0.568 |
| Passenger Shelter Program | + 38,205 | + 38,205 | 0 | 1.000 | + 16,795 | 1,877,000 | -2,213,972 | +10,301,600 | + 2,575,400 | 0.785 |
| Fare Increase (+10%) | -551,716 | -541,660 | - 10,056 | 0.982 | + 541,660 | 0 | -2,755,632 | +10,301,600 | + 2,575,400 | 0.800 |
| New Garage Project | +183,906 | +301,039 | -117,133 | 0.611 | + 80,845 | 20,000,000 | -2,836,477 | +26,301,600 | + 6,575,400 | 0.480 |

**Notes:**

a. The pasmark's value of |0.785| is used in these computations.

b. Estimated from Table 3-4 (Column 7).

c. Estimated from Equations (3.8), (3.9), and (3.10) using adjusted cost figures reflecting the Federal capital subsidy.

d. Estimated from Table 3-4 (Column 6).

e. No adjustment is necessary for the effect of Federal operating subsidies since USA Transit subsidy requirements exceed the UMTA ceiling on Federal operating subsidies.

f. The service cut policy results in a loss of 1,046,650 passenger trips but in a gain of $1,841,175 in net revenues.

## A GRAPHICAL REPRESENTATION

The evaluation of policies and projects using the passmark concept of passenger trips per dollar is illustrated in Figure 3-1. In this diagram, projects and policies are plotted according to their effects on passenger trips and net revenues. The dashed diagonal line represents the performance standard or passmark of 0.785 passenger trips per dollar. The acceptable projects and programs are portrayed to the right and above the passmark line. Unacceptable projects appear below and to the left of the passmark line. The marginal project appears on the passmark line. As may be seen from Figure 3-1, the fare increase policy and the new garage project are to the left of the passmark line in the unacceptable zone. Net returns are measured by the vertical distance between the point representing the project or policy and the diagonal passmark line. If the value of the passmark is changed, then the dashed diagonal line will rotate and the acceptability of projects will change. If the passmark is increased to 2.0 passenger trips per dollar, all the projects that gain net revenues will be feasible or acceptable, while all the projects which lose net revenues, are infeasible. This occurs because the changing passmark involves changing the value of passenger trips in terms of net revenues.

The utility or usefulness of the performance standard or passmark is that it allows one to trade projects and policies. If the passmark value is lowered some money producing projects (whose loss in passenger trips is now not sufficient to reach the passmark) will be rejected, but at the same time some money spending projects will be approved. As the passmark is decreased, the net revenues generated through project selection will decrease and the total passenger trips will increase. The opposite is true of an increase in the passmark value, which leads to increases in net revenues and declines in ridership. By altering the slope of the diagonal line it is possible to either include more projects of the money saving type or conversely more projects of the passenger trips generation type. The slope of the line is thus determined by the subsidy level or availability of monies. The less money is available, the further the line must be rotated in a counter clockwise direction in order to cut out the money losing projects and increase the number of money gaining projects. The passmark or performance standard provides the transit planners with a tool to allocate the subsidy among competing claims of projects and policies while accomplishing the corporate objective of maximizing ridership.

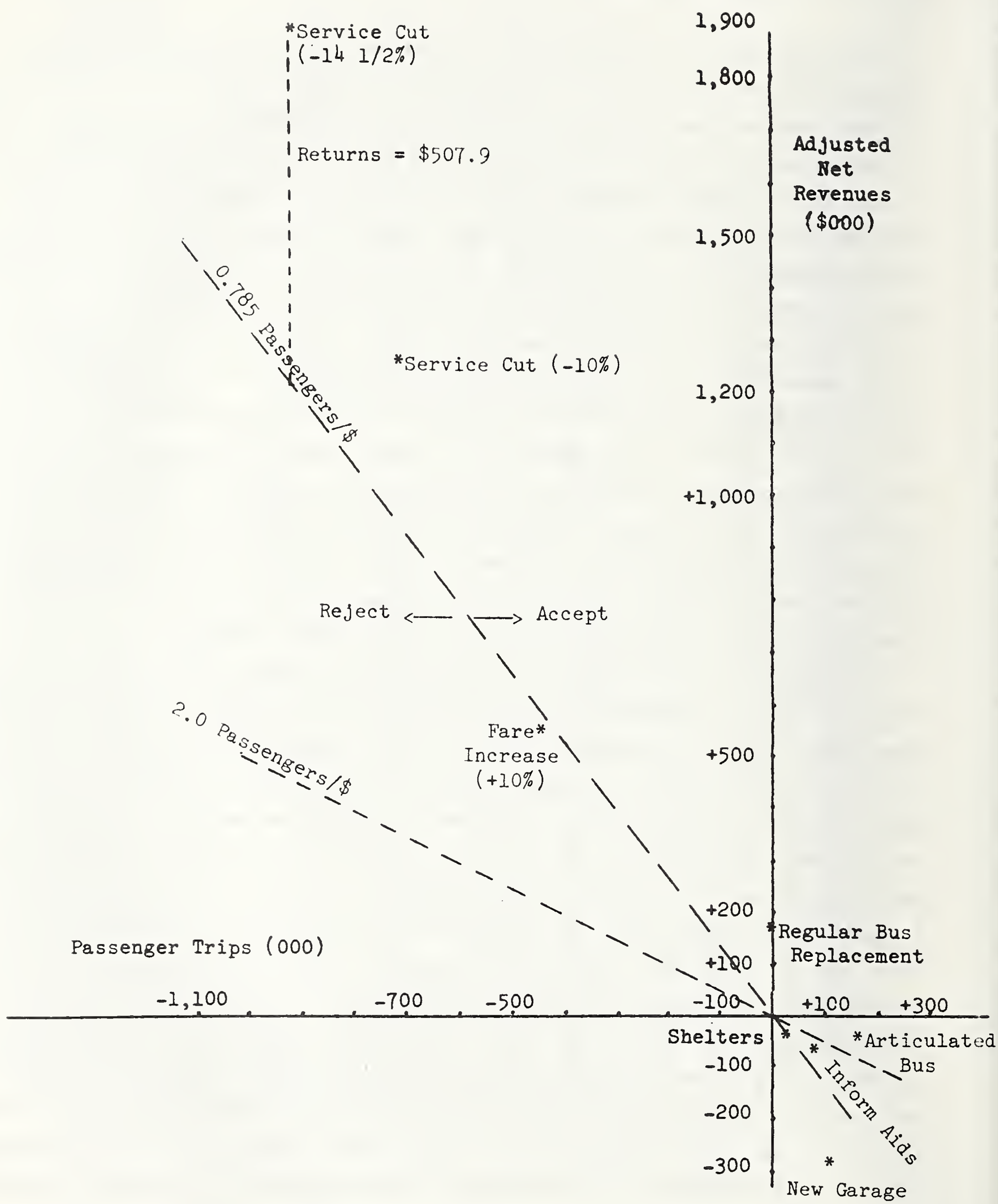



Figure 3-1: USA TRANSIT -- GRAPHICAL REPRESENTATION OF DECISION RULES
USING THE PERFORMANCE STANDARD OR PASSMARK

SIMILARITIES WITH THE CORPORATE INTERNAL RATE OF RETURN

There are several elements in common between the passmark and the decision rules used in the corporate sector. Taking as an example the internal rate of return, the analytical tool most commonly used in the corporate sector for capital budgeting purposes, the similarities are numerous.

The internal rate of return, defined as the interest rate that equates the present value of net revenues to the present value of operating and capital costs of the investment, is derived directly from the corporate objective of maximizing the net worth or the market value of the corporation, subject to constraints on availability of funds, debt capacity, etc. The passmark or performance standard is also derived directly from the transit company objective of maximizing transit user and community benefits subject to a constraint on the subsidy level. In the passmark case, however, the assumption that user and community benefits depend on ridership is required, which is an assumption that holds true in the absence of major disparities in elasticity responses among the transit market segments.

The internal rate of return computation is conducted in present value terms, while the passmark or performance standard can use either equivalent present values or annualized values of both ridership and costs. The internal rate of return is also used to determine benefit-cost ratios (or ratios of present values of net revenues to present values of costs), while the passmark levels are similarly used to determine return ratios. In both instances projects with benefit-cost ratios or return ratios greater than 1.0 are undertaken.

Decision rules designed for screening projects in the corporate sector are also similar to the decision rules with the passmark. In the corporate case projects are undertaken if their internal rates of return exceed the market rate of interest or the marginal cost of funds. In the transit case, projects are undertaken if their passengers per dollar of net revenue exceed the passmark for projects which result in negative net revenues. That is, there are numerous similarities between the two concepts.[1]

[1]For an analysis of these similarities see: Armando M. Lago and Patrick D. Mayworm, "Transit Means Business: A Corporate Planning Approach to Transit Fare and Service Planning." Transportation Quarterly. Vol. 36, No. 3, July 1982, pp. 335-350.

However some differences are also present. The passmark methodology encounters problems evaluating projects that do not have an effect on passenger trips. For example, suppose some repair shop machinery is to be replaced in a normal replacement program which has no effect on ridership. In this case either present value analysis or minimum cost decisions need to be undertaken rather than passmark computations. In general, when projects have no direct or an indirect effect on ridership, their selection should be based on the net present value of the project after discounting the cash flows at the transit property's borrowing rate.

A final word of caution is in order. Determination of the passmark level and its use in allocating resources does not imply that the subsidy level is appropriate. In fact, the analysis presented in this section assumes that the subsidy level is cost-effective, so that the passmark appropriate to that subsidy level is determined.

# 4

CORPORATE PLANNING AND TRANSIT POLICY

IDENTIFYING CORPORATE OBJECTIVES AND CONSTRAINTS

DEVELOPING A PERFORMANCE STANDARD

**BALANCING FARE AND SERVICE LEVELS**

DEVELOPING THE FIVE-YEAR INVESTMENT PROGRAM

# 4

## BALANCING FARE AND SERVICE LEVELS

One important application of the corporate planning approach is in the synchronization of fare and service policies, which in conventional transit planning applications are usually planned somewhat independently of each other.

The hypothetical example of USA Transit in Chapter 3 showed a situation where fares and services were unbalanced. In that case,[1] fares and service levels were found to be higher than appropriate, and returns to fare policy changes were found to be inferior to the returns from reductions in service levels. This chapter expands on the concepts used in synchronizing and balancing fares and service policies.

### RULES FOR BALANCING FARES AND SERVICE LEVELS

Balancing fares and service levels entails finding the optimal combination of fares and service levels which meet the budget constraint while maximizing ridership.

A start in the direction of balancing or synchronizing fares and services is to compare the passenger trips per dollar of net cost from fare and service changes. Using the example presented in Chapter 3 (see Table 3-4), ten percent increases in fare levels may be compared with ten percent reductions in service

[1]See Tables 3-4 and 3-7 and the corresponding text in Chapter 3.

levels (bus miles), assuming constant fares and service elasticities of demand. The resulting passenger trips per dollar of net cost for these two policies are:

| Policies | Passenger Trips (000) | Net Costs (000) | Passenger Trips Per Dollar |
|---|---|---|---|
| 10% Fare Increases | -433.1 | $ -541.66 | 0.800 |
| 10% Service (bus miles) Reductions | -721.8 | -1,269.73 | 0.568 |
| Both Policies | -1,154.9 | $-1,811.39 | 0.638 |

Comparing these two policies, it may be observed that the loss in passenger trips per dollar of net costs is less for service reductions than for fare increases. This suggests that the proper policy is certainly to reduce bus miles even further, while avoiding fare increases. In other words, the fare level is too high and the service level is also greater than could be justified by efficiency considerations of providing the most passenger trips under a given budget constraint.

The budget balancing solution provided in Table 3-7 is to avoid fare changes and to reduce service (bus miles) by 14 1/2 percent. This policy generates the following results, which are clearly superior to the first option analyzed, since it generates approximately equal amounts of money but at a smaller loss in passenger trips:

| Policies | Passenger Trips (000) | Net Costs (000) | Passenger Trips Per Dollar |
|---|---|---|---|
| 14 1/2% Service (bus miles) Reductions | -1,046.65 | $-1,841.18 | 0.568 |

However, the 14 1/2 percent reduction in service (with no fare revision) does not provide either for the optimal balance between fares and service levels. This optimal balance is arrived at when the passenger trips per dollar of net cost of small changes in both fares and service options are approximately similar. That is, for optimal fare and service balance, the passenger trip loss (gains) per dollar of net revenue gain (loss) from small service reductions (increases) must equal the passenger trip gains (loss) per dollar of net revenue loss (gain) from small fare reductions (increases). This optimal balance condition may be expressed as:

$$(4.1)\quad \frac{\text{loss (gain) in passenger trips from small service changes}}{\text{dollar gains (loss) from small service changes}} = \frac{\text{gain (loss) in passenger trips from small fare changes}}{\text{dollar loss (gains) from small fare changes}}$$

This optimal balancing condition of equality at the margin between changes in fares and service levels may be proved mathematically.[1] It means that the

[1]For example, maximization of ridership subject to the subsidy contraint, such as in:

MAX: $Z = \text{Passenger Trips} + \lambda\ (\text{Net Revenues} + \text{Subsidy})$

results in:

$$(a)\quad \frac{\partial Z}{\partial f} = \frac{\partial \text{Passenger Trips}}{\partial f} + \lambda \frac{\partial \text{Net Revenues}}{\partial f} = 0$$

$$(b)\quad \frac{\partial Z}{\partial bm} = \frac{\partial \text{Passenger Trips}}{\partial bm} + \lambda \frac{\partial \text{Net Revenues}}{\partial bm} = 0$$

and

$$(c)\quad \frac{\partial Z}{\partial \lambda} = \text{Net Revenues} + \text{Subsidy} = 0$$

and dividing (a) into (b) and rearranging terms results in:

$$(d)\quad \frac{\partial \text{Passenger Trips}/\partial bm}{\partial \text{Net Revenues}/\partial bm} = \frac{\partial \text{Passenger Trips}/\partial f}{\partial \text{Net Revenues}/\partial f}$$

where f represents fare levels, bm represents bus miles and $\lambda$ represents the lagrangian multiplier or passmark. In the objective function Z, Passenger Trips and Net Revenues are functions of fares and services.

least value for money from service level changes will be the one at which passenger trips gained (lost) from further small service increases (reductions) are just offset by the passenger trips lost (gained) by the small fare increase required to finance it.

In terms of the hypothetical USA Transit example presented in Chapter 3, the appropriate balance between fare and service levels is arrived at by estimating the combination of fare and service changes which generates approximately \$1.85 million savings in operating subsidies (corresponding to the 14 1/2% reduction in bus miles supplied) with a minimum loss in ridership. The fare and service combination which generates the required net revenue to meet subsidy constraints at minimum loss in passenger trips represents the efficient solution or optimal balance between fares and services. At this point of optimal balance, the marginal returns (in terms of passenger miles per dollar of net revenue) from fares and service changes are equal.

Table 4-1 presents the combinations of fares and service level changes required to generate approximately \$1.85 million in net revenues, assuming service elasticities are constant and fare elasticities are proportional to the average fare paid per passenger.[1] As shown in Table 4-1, combinations of fare increases and small service reductions are markedly inferior in terms of ridership losses to combinations of both service and fare reductions. For example, the combination of a ten percent fare reduction and an 18.7 percent service reduction results in smaller ridership losses than the combination of a ten percent fare increase and a 10 3/4 percent service reduction, while raising essentially the same amount of money. The conclusion in the example of USA Transit is that fares need to be reduced and deeper cuts in service must be made to finance the reduction in Federal subsidies at minimum ridership loss.

As shown in Table 4-1, the options with greater fare and service cuts exhibit smaller ridership losses, as indicated by the lower average passenger trips per dollar for these options. The differential between average passenger

[1]The service elasticity, in terms of bus miles, is given by $\mathcal{E}_{bm} = +0.5$, while the fare elasticity is given by: $\mathcal{E}_f = \alpha(f)$ where f is the average fare paid and $\alpha$ is the proportionately coefficient. Assuming a -0.3 fare elasticity at the current fare level of \$0.56, the fare elasticity formula becomes $\mathcal{E}_f = -0.5357(f)$. This formulation of the fare elasticities is different than the constant fare elasticities stipulated in Chapter 3.

Table 4-1

USA TRANSIT

ALTERNATIVE FARE AND SERVICE COMBINATIONS
FOR MEETING SUBSIDY REQUIREMENTS -- 1984

| Policy Options | | Changes in Passenger Trips (000) | Changes in Net Costs (000) | Average Passenger Trips Per Dollar |
|---|---|---|---|---|
| Option 1 | | | | |
| Fares: | +30% | -1,494.2 | $-1,337.6 | 1.117 |
| Bus Miles: | -4.5% | - 324.8 | - 516.8 | 0.628 |
| | | -1,819.0 | -1,854.4 | 0.981 |
| Option 2 | | | | |
| Fares: | +10% | - 454.8 | - 528.3 | 0.861 |
| Bus Miles: | -10.75% | - 776.0 | -1,321.6 | 0.587 |
| | | -1,230.8 | -1,849.9 | 0.665 |
| Option 3 | | | | |
| Fares: | +5% | - 222.0 | - 270.5 | 0.821 |
| Bus Miles: | -12.6% | - 909.5 | -1,574.5 | 0.578 |
| | | -1,131.5 | -1,845.0 | 0.613 |
| Option 4 | | | | |
| Fares: | 0% | 0 | 0 | 0 |
| Bus Miles: | -14.6% | -1,053.9 | -1,853.8 | 0.569 |
| | | -1,053.9 | -1,853.8 | 0.569 |
| Option 5 | | | | |
| Fares: | -10% | + 411.4 | + 601.1 | 0.684 |
| Bus Miles: | -18.7% | -1,349.8 | -2,450.1 | 0.551 |
| | | - 938.4 | -1,849.0 | 0.508 |
| Option 6 | | | | |
| Fares: | -15% | + 600.9 | + 926.6 | 0.648 |
| Bus Miles: | -20.9% | -1,508.6 | -2,780.6 | 0.543 |
| | | - 907.7 | -1,854.0 | 0.490 |
| Option 7 | | | | |
| Fares: | -20% | + 779.6 | +1,267.6 | 0.615 |
| Bus Miles: | -23.1% | -1,667.4 | -3,119.9 | 0.534 |
| | | - 887.8 | -1,852.3 | 0.479 |
| Option 8 | | | | |
| Fares: | -25% | + 947.4 | +1,623.2 | 0.584 |
| Bus Miles: | -25.3% | -1,826.2 | -3,468.2 | 0.527 |
| | | - 878.8 | -1,845.0 | 0.476 |
| Option 9 | | | | |
| Fares: | -30% | +1,104.4 | +1,992.4 | 0.554 |
| Bus Miles: | -27.6% | -1,992.2 | -3,839.3 | 0.518 |
| | | - 887.8 | -1,846.9 | 0.481 |

Note: Changes in passenger trips are estimated using mid-point elasticities. Decreases in net costs are identical to increases in net revenues.

trips per dollar of net cost for service and fare reductions also narrows. The optimal balance between fare and services is achieved at Option 8 which specifies a 25 percent cut in fares and a 25.3 percent reduction in bus miles. Option 8 generates the required net revenue target at minimum passenger trip loss, as indicated by its lower average passenger trips per dollar of net cost. At this option the ratios of passenger trips per dollar of net cost for small (marginal) changes in fares and services are equal.

In light of the results presented in Table 4-1, the budget balancing solution presented in Table 3-7 is clearly inefficient. Rather than reducing bus miles by 14 1/2 percent, the appropriate or optimal balancing solution would have been to reduce fares by 25 percent and reduce service (bus miles) by 25.3 percent. Fares and service policies therefore, cannot be planned independently of each other, because there is a loss associated with their lack of synchronization or balance. This loss is reflected in greater reductions in ridership than would have been warranted by policies which are optimally balanced.

## ADJUSTING SERVICE LEVEL CHANGES

The next step in the fare and service coordination process is to adjust the service level to correspond to the optimal fare and service levels presented in Table 4-1. This optimal service coordination policy required a 25.3 percent reduction in bus miles supplied.

The task now for USA Transit is to plan for the reduction in service by adjusting bus mileage at the route level for its 66 routes. The first step in this analysis is to develop costs and revenue information at the route level.

### Costs and Revenues at the Route Level

USA Transit utilizes a simple cost allocation formula that allccates costs on a route level depending on bus mileage, bus hours, and peak vehicles in use. Table 4-2 presents the estimation of the cost allocation formula of USA Transit.

On the basis of the information presented in Table 4-2, USA Transit's cost allocation formula is:

(4.2) $\quad$ (Cost) = 0.73 (Bus Miles) + 19.42 (Hours) + 11,158 (Peak Vehicles)

Table 4-2

USA TRANSIT
COSTS AND COST ALLOCATION FORMULA -- 1984 PRELIMINARY

| Cost Categories | Expenses (000) | Activity Units (000) | Cost Per Unit (000) |
|---|---|---|---|
| 1. <u>Costs Dependent on Vehicle Hours</u> | | | |
| Drivers Wages and Fringe Benefits<br>Scheduling Costs | $ 9,709 | 500 vehicle hours | $19.42 |
| 2. <u>Costs Dependent on Vehicle Miles</u> | | | |
| Vehicle Maintenance Costs<br>Fuel and Lubricants (including taxes)<br>Tires and Tubes (including taxes)<br>Inspections Costs | $ 4,353 | 6000 vehicle miles | $0.73 |
| 3. <u>Costs Dependent on the Number of Peak Vehicles</u> | | | |
| Maintenance of Service Vehicles<br>Maintenance of Building and Facilities<br>Utilities<br>Interest Expenses<br>Vehicle Licensing and Registration<br>Vehicle Insurance<br>Fare Collection and Counting Costs<br>Marketing<br>Planning and Transit Development<br>General Administration | $ 2,678 | 0.24 vehicles | $11,158 |
| Total | $16,740 | | |

The cost allocation formula was used to compute costs at the route level for the 66 routes. The costs, revenues, and ridership data of each route were then used to compute the average passenger trips per dollar of net cost on each route. These computations assume that the 25 percent fare reduction was implemented. Table 4-3 presents an example of the computations for the 15 worst routes of USA Transit in terms of passenger trips per dollar of net cost.

These 15 worst routes have average passenger trips per dollar of losses well under the passmark level of 0.785 passenger trips per dollar determined in Chapter 3. That is, service on these routes should not be provided without extensive route modifications or headway changes. In general, the corporate planning methodology analyzes route changes and modifications in a fashion identical to the methodology used for budgeting. Thus, money losing routes are analyzed in an identical manner to money losing capital projects.

## Planning Service Changes at the Route Level

The basic methodology for planning service level changes is to effect service changes for routes whose contribution to the corporate objective (in terms of passenger trips per dollar of net cost) is below that of the marginal project or passmark level. The service changes effected should bring the passengers trips per dollar of net cost for a given route to the standard or passmark level.

The changes that can be effected at the route level to bring the returns at the route level to the standard value or passmark include frequency changes, routing changes, (including route cutbacks and route eliminations), scheduling changes (including improved running times, time span of service) and the provision of new services such as route extensions, express service and bus priority treatments. Since the focus of the USA Transit example is on service level reductions, the examples presented below focus on service actions that reduce the bus mileage supplied by USA Transit.

Evaluating changes in services at the route level requires the specification of appropriate service elasticities of demand for a given route. The evidence on service elasticities is that they vary by time-of-day and several other factors. Research conducted by Ecosometrics, Inc. for UMTA's Office of

Table 4-3: USA TRANSIT -- WORST ROUTES IN TERMS OF PASSENGER TRIPS PER DOLLAR

| Routes | Annual Vehicle Hours (000) (1) | Annual Vehicle Miles (000) (2) | Peak Vehicles (3) | Annual Passengers (000) (4) | Operating Revenues[a] (000) (5) | Costs (000) (6) | Net Costs[a] (000) (7)=(6)-(5) | Average Passenger Trips Per Dollar[a] (8)=(4)÷(7) |
|---|---|---|---|---|---|---|---|---|
| 43 | 8.6 | 103 | 6 | 60 | $ 25.2 | $309.1 | $ 283.9 | 0.21 |
| 21 | 7.5 | 90 | 4 | 50 | 21.0 | 234.9 | 213.9 | 0.23 |
| 28 | 6.4 | 70 | 4 | 50 | 21.0 | 220.0 | 199.0 | 0.25 |
| 19 | 10.5 | 115 | 5 | 80 | 33.6 | 343.7 | 310.1 | 0.26 |
| 62 | 7.7 | 85 | 6 | 70 | 29.4 | 278.5 | 249.1 | 0.28 |
| 13 | 8.2 | 98 | 5 | 76 | 31.9 | 286.6 | 254.7 | 0.30 |
| 8 | 8.4 | 92 | 4 | 75 | 31.5 | 274.9 | 243.4 | 0.31 |
| 51 | 7.5 | 82 | 3 | 69 | 29.0 | 239.0 | 210.0 | 0.33 |
| 58 | 9.7 | 97 | 4 | 90 | 37.8 | 303.8 | 266.0 | 0.34 |
| 47 | 10.2 | 112 | 6 | 108 | 45.3 | 346.8 | 301.5 | 0.36 |
| 65 | 8.7 | 104 | 4 | 92 | 38.6 | 289.5 | 250.9 | 0.37 |
| 29 | 8.7 | 100 | 5 | 98 | 41.2 | 297.7 | 256.5 | 0.38 |
| 33 | 8.2 | 98 | 3 | 91 | 38.2 | 264.3 | 226.1 | 0.40 |
| 54 | 8.9 | 97 | 5 | 113 | 47.5 | 299.4 | 251.9 | 0.45 |
| 5 | 8.8 | 95 | 4 | 110 | 46.2 | 284.5 | 238.3 | 0.46 |

Note

[a]Assumes a 25 percent fare reduction from the previous $0.56 average fare paid per passenger, thereby corresponding to the optimal fare policy.

Service and Methods Demonstration[1] (SMD) showed that off-peak services have higher service elasticities than peak-hour service, and that services with wide headways also exhibit higher service elasticities than short headway services. In addition, partial evidence supports the view that elasticities from cuts in services (bus miles) are higher than those arising from increased scheduled service levels. However, to simplify the computations, the bus miles service elasticities assumed below are set at a constant value ($\mathcal{E}_{bm} = +0.5$).

Because of the impossibility of analyzing each of the 14 worst routes in detail, an example is provided for the changes to be recommended on a sample route -- Route 21. The extension of this analysis on the sample route to the other routes is straightforward.

## The Route 21 Example

Route 21 is among the worst routes in USA Transit's network. Its returns of 0.23 passenger trips per dollar of net cost are well below the pass-mark level. As such, service should not be provided on this route without extensive modifications.

The task at hand for Route 21 is to change headways or reduce the mileage of the route by cutbacks. Also possible, but not considered here, is a reduction in the span or hours of service. The Route 21 modification options entail reducing service from the four hourly buses currently assigned to the route, to one bus every two hours. The options available and their costs and revenue impacts are presented in Table 4-4. Selection of the appropriate option for service along Route 21 should be conducted in terms of the net returns formulas presented in Chapter 3 [see Equations (3.8) to (3.10)]. Selection of the option with the highest passenger trip per dollar of net cost does not always result in the correct decision.

---

[1]Armando M. Lago, Patrick D. Mayworm, and J. Matthew McEnroe. "Transit Service Elasticities." Journal of Transport Economics and Policy. May 1981. The elasticities presented in this article came from the catalogue of fare and service elasticities compiled in Ecosometrics, Inc. Patronage Impacts of Changes in Transit Fares and Services. Prepared for UMTA's Office of Service and Methods Demonstration, Report PB-81-167-652, Bethesda, Maryland, September 1980.

Table 4-4

USA TRANSIT
TRANSIT SERVICE OPTIONS FOR ROUTE 21

| Route 21 Service Options | Reduction in Bus Miles (%) (1) | Annual Passengers[a] (000) (2) | Annual Revenues (000) (3) | Annual Costs[b] (000) (4) | Annual Net Costs (000) (5)=(4)-(3) | Average Passenger Trips Per Dollar (6)=(2)÷(5) |
|---|---|---|---|---|---|---|
| 4 buses per hr. | 0.00 | 50.00 | $21.00 | $234.9 | $ 213.90 | 0.23 |
| 3 buses per hr. | 25.00 | 43.75 | 18.38 | 176.18 | 157.80 | 0.28 |
| 2 buses per hr. | 50.00 | 37.50 | 15.75 | 117.45 | 101.70 | 0.37 |
| 1 bus per hr. | 75.00 | 31.25 | 13.13 | 58.73 | 45.60 | 0.69 |
| 3/4 bus per hr. | 81.25 | 29.69 | 12.47 | 44.04 | 31.57 | 0.94 |
| 1/2 bus per hr. | 87.50 | 28.13 | 11.81 | 29.36 | 17.55 | 1.60 |

[a]Assumes a +0.5 service elasticity of demand.

[b]Estimated from the cost allocation formula presented in Equation (4.2).

As shown in Table 4-5, the net returns (evaluated at the passmark level of 0.785 passenger trips per dollar) are positive only for the reduced service options of 3/4 and 1/2 buses per hour, that is wide headways such as those that prevail in suburban off-peak service. These headway modifications on Route 21 result in reductions of 81 1/4% - 87 1/2% of the bus miles supplied on this route.

## Extensions of the Analysis to Other Routes

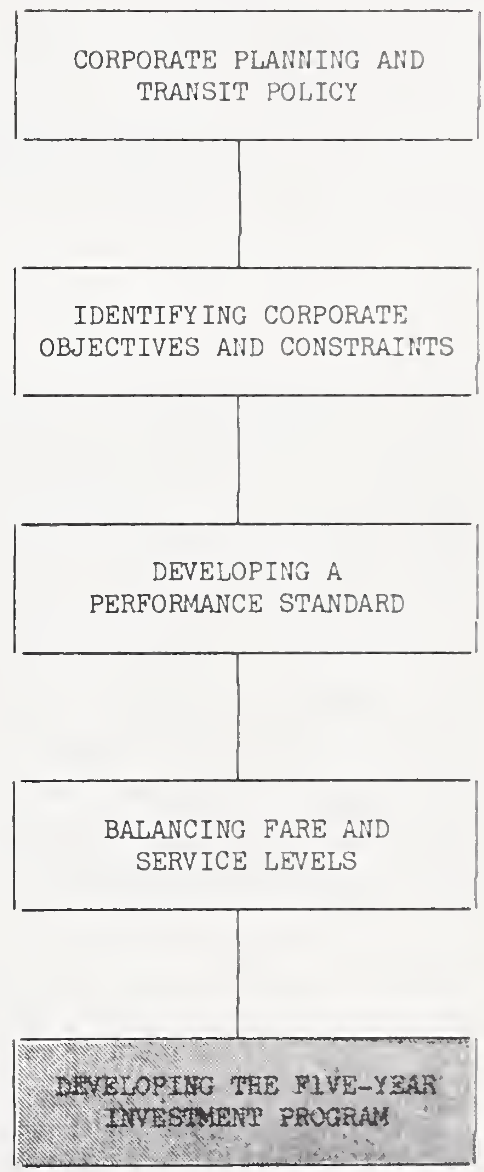
The analytical procedure followed for Route 21 can now be extended to other routes. The aim of this analysis should be to reduce bus mileage by 25.3 percent for all the routes in USA Transit's route network.

Table 4-5

USA TRANSIT
RETURNS AND RETURN RATIOS FOR SERVICE OPTIONS ON ROUTE 21

| Route 21 Service Option | Annual Passenger Trips ÷ Passmark (000) (1) | Annual Net Costs (000) (2) | Annual Net Returns (000) (3)=(1)-(2) | Return Ratio (4)=(1)÷(2) |
|---|---|---|---|---|
| 4 buses per hour | 63.70 | $ 213.90 | $-150.20 | 0.30 |
| 3 buses per hour | 55.70 | 157.80 | -102.10 | 0.35 |
| 2 buses per hour | 47.70 | 101.70 | -54.00 | 0.47 |
| 1 bus per hour | 39.80 | 45.60 | -5.80 | 0.87 |
| 3/4 bus per hour | 37.82 | 31.57 | +6.25 | 1.20 |
| 1/2 bus per hour | 35.80 | 17.55 | +18.25 | 2.04 |

# 5


CORPORATE PLANNING AND TRANSIT POLICY
IDENTIFYING CORPORATE OBJECTIVES AND CONSTRAINTS
DEVELOPING A PERFORMANCE STANDARD
BALANCING FARE AND SERVICE LEVELS
DEVELOPING THE FIVE-YEAR INVESTMENT PROGRAM

# 5

## DEVELOPING THE FIVE-YEAR INVESTMENT PROGRAM

The final task in transit corporate planning is the development of the five-year investment program.[1] Development of five-year investment programs are warranted for a variety of reasons. Capital projects take several years to implement and become fully operational, and during these construction years they exact a pressure on the finances of the transit company. A decision to construct a garage today may require expenditures for two-three years in the future, linking several time periods for financial planning purposes. In addition, the variable nature of capital markets, where interest rates and the availability of capital vary significantly from year to year, suggests the need to borrow when interest rates and borrowing terms are the most propitious, which itself requires an accurate estimation of the amount of funds to be borrowed over a period of years.

### TYPE OF CAPITAL PROJECTS

Capital projects may be classified into several categories that differ in their evaluation requirements. These categories include:

1. "Like-for-like" replacements and renewals.
2. Betterments and new projects without impacts on ridership.
3. Betterment or new projects with impacts on ridership.

---

[1] The five-year period may be too short for capital budget planning. Some transit properties, particularly in Europe, develop even longer programs, such as ten-year capital budgets.

### Replacements and Renewals

The "like-for-like" replacement and renewal refer to investment required to maintain the transport system as it is currently in terms of operational efficiency and safety. These investments refer to essential renewals and replacements of rolling stock, building structures, electrical plants (if present), and even bridges and other permanent ways. Evaluation of the feasibility of these one-for-one replacements is determined in reference to engineering standards or practice. Usually the resources to be spent in providing these like-for-like replacements are reflected in the depreciation provisions. Projects of this category that are accepted should correspond to the minimum life cycle cost replacement alternative.

The feasibility of some "like-for-like" replacement projects, such as bus replacement, can also be determined using standard financial tools, such as present value analysis. For example, the net present value of bus replacement programs can be determined by trading-off the present value of savings in vehicle operating costs (mostly repair and maintenance) from replacing old buses in the fleet to the extra costs of the new buses above the sale value of the old buses. It is also true that the bus replacement decision is sometimes resolved using industry standards or in some instances following the UMTA Federal capital subsidy regulations.

### Betterments and New Projects Without Impacts on Ridership

Another category of projects refer to those that have no impact on ridership. An employee safety program provides examples of projects in these categories. In this case, evaluation and project selection is determined using conventional capital budgeting techniques, such as net present value of the investment. For example, for the safety project, the returns in terms of smaller casualty and health insurance costs, workmen's compensation, disability payments and time lost at work would be compared with the cost of the safety program in a net present value computation.

### Betterments and New Projects Which Impact on Ridership

This category of projects includes betterments (or improvements over normal replacements and renewals) and new projects that affect ridership. Examples include replacing conventional buses with articulated buses on congested runs, passenger information aids, etc. These projects should be evaluated in terms of their "passenger trips per dollar" impact and compared with the passmark to determine their acceptance or rejection.[1]

Some projects also contain benefits or impacts difficult to quantify. For example, benefits such as staff morale and employee relations, public relations, and improving the image of the transit operator resist quantification into dollar benefits. However, these unquantifiable impacts need to be taken into account, particularly for those projects whose net returns are negative. In these cases, the decision-makers need to ask themselves whether the importance of these non-quantifiable benefits are enough to overcome the negative returns (according to Equation 3.8) of the project.

## DEVELOPING THE INVESTMENT PROGRAM

The conventional corporate planning approach is to submit annually a five-year investment plan. The five-year capital budget is updated every year and the commitments for the year in question appear in the capital and revenue or operating budget for that year. The investment program developed in this section closely resembles the operating budget presented in Chapter 3.

---

[1]In situations where there are separate constraints for operating and capital subsidies, and it is not possible to trade-off operating for capital subsidies, a separate passmark for capital projects may be in order. In terms of the mathematics of constrained maximization, maximizing ridership with respect to constraints on capital and operating subsidies can be expressed as follows:

$$(5.1)\quad \text{MAX:}\quad Z = \text{Passenger Trips} + \lambda_1 (\text{Revenues} + \text{Operating Subsidy} - \text{Costs}) + \lambda_2 (\text{Capital Subsidy})$$

This formulation results in separate estimates of the values of fares (f), bus miles (bm), operating policies passmark ( $\lambda_1$) and capital project passmark ( $\lambda_2$) which maximize ridership subject to the subsidy constraints. The lagrangian multipliers $\lambda_1$ and $\lambda_2$ represent the shadow cost of operating and capital subsidies. They represent separate but related passmark values. In Equation (5.1), Passenger Trips, Revenues, and Costs are functions of fares, service levels, and capital investments.

The role of the transit investment program is to: (1) provide an inventory of the resources to be spent on investment, (2) prioritize the investment projects and their inherent resource commitments, (3) estimate the returns on the investment program and effect a rational allocation of resources on the basis of the returns and priorities, and (4) provide a planning focus for internal management control purposes.

As a starting point the Transit Board, taking into account external commitments of funds from Federal and state sources, should set the probable level of resources to be spent for capital projects during the five-year period. In this example, a target level of $10 million was set for the capital budget of USA Transit, after taking into account Federal commitments of $40 million for capital subsidies during the five-year period. In addition, given trends in Federal funding for operating assistance, the Transit Board expects to be requiring operating subsidies exceeding the Federal cap on operating subsidies. A situation similar to the one encountered in Chapter 3.[1] The Transit Board should ask the planning staff to prepare alternatives including a preferred investment program and several reduced investment options.

Developing the Investment Program Options

Following the guidelines of the Transit Board, the planning and financial staff developed four options which are shown in Table 5-1. These options include the preferred investment plan presented earlier. The lowest investment option should correspond to the financing of like-for-like replacements and renewals necessary to keep the transit system at the same operational efficiency level as before. The other intermediate options should reflect the ranking of projects in terms of priorities or in terms of net returns ratios (using the information on passenger trips per dollar of net cost generated by the capital projects). Table 5-2 presents the prioritized options. On the assumption that some level of public transit service is necessary, some level of investment is required. A detailed analysis of the consequences of eliminating all investments comprise so many uncertainties that it would not be meaningful in making decisions. Therefore, the zero investment option is not analyzed. Instead, the focus of the analysis on the quantification of investment returns, analyzing the effects of varying levels of investments over a range which would encompass any likely possible decision.

---

[1]This assumption means that there is no need for adjustments due to the influence of Federal operating subsidies, since USA Transit will be operating at levels exceeding the UMTA ceiling on Federal operating subsidies.

Table 5-1: USA TRANSIT -- PREFERRED INVESTMENT PROGRAM 1984-1988[a]
(in millions of 1984 dollars)

| Projects and Programs | 1984 | 1985 | 1986 | 1987 | 1988 | 1984 -- 1988 Total | 1984 -- 1988 Federal Share | 1984 -- 1988 Non-Federal Share |
|---|---|---|---|---|---|---|---|---|
| Articulated Buses | $5.0 | $ - | $5.0 | $ - | $5.0 | $15.0 | $12.0 | $ 3.0 |
| Conventional Bus Replacement | 6.0 | - | 2.0 | - | 4.0 | 12.0 | 9.6 | 2.4 |
| Park-N-Ride Lots | - | 1.0 | 4.0 | 11.0 | 5.0 | 21.0 | 16.8 | 4.2 |
| Bus Stations Improvements | - | - | 1.5 | 2.0 | 4.0 | 7.5 | 6.0 | 1.5 |
| Bus Radio and Communications | - | - | - | 2.0 | 1.5 | 3.5 | 2.8 | 0.7 |
| New Garage[b] | 10.0 | 10.0 | - | - | - | 20.0 | 16.0 | 4.0 |
| Conventional Garage Renovation[c] | - | - | 2.0 | 4.5 | 4.0 | 10.5 | 8.4 | 2.1 |
| Passenger Information Aids[d] | - | 1.5 | 1.5 | 0.5 | 0.5 | 4.0 | 3.2 | 0.8 |
| Staff Safety | - | 2.5 | 1.5 | 0.7 | 0.3 | 5.0 | 4.0 | 1.0 |
| Passenger Safety and Amenities | 1.5 | 0.5 | 1.0 | 0.4 | 0.4 | 3.8 | 3.0 | 0.8 |
| Total | $22.5 | $15.5 | $18.0 | $21.1 | $24.7 | $102.3 | $81.8 | $20.5 |

Notes:

[a]The expenses in 1984 and the early months of 1985 correspond to the capital projects described earlier in Chapter 3 (Table 3-4).

[b]The capital expenditures for the new garage were to be committed in 1984, but the actual expenditures would be made over a two-year period.

[c]Conventional like-for-like renovation of old garages is programmed to occur from 1986 to 1988.

[d]The passenger information aids shown in Table 3-4 comprised non-capital expenditures (leaflets, etc.) during 1984, but expenditures in later years include computers, telephone information systems and others.

Table 5-2

USA TRANSIT
PRIORITIZATION OF FIVE-YEAR INVESTMENT PROGRAM OPTIONS
(millions of 1984 dollars)

| Investment Program Options | Federal Share Costs (1) | LOCAL SHARE COSTS | | | |
|---|---|---|---|---|---|
| | | All (2) | Replacement Projects (3) | Betterments and New Projects: Without Ridership Impacts (4) | Betterments and New Projects: With Ridership Impacts (5) |
| **Preferred Program** | | | | | |
| New Garage | $ 16.0 | $ 4.00 | $ -- | $ -- | $ 4.00 |
| Bus Stations Improvements | 6.0 | 1.50 | -- | 1.50 | -- |
| Bus Radio & Communications | 2.8 | 0.70 | -- | 0.70 | -- |
| Staff Safety | 4.0 | 1.00 | -- | 1.00 | -- |
| Projects in 1st Reduced Program | 53.0 | 13.30 | 4.50 | 0.54 | 8.26 |
| | $ 81.8 | $20.50 | $4.50 | $3.74 | $12.26 |
| **First Reduced Program** | | | | | |
| Articulated Buses | $ 12.0 | $ 3.00 | $ -- | $ -- | $3.00 |
| Passenger Safety & Amenities | 3.0 | 0.80 | -- | 0.27 | 0.53 |
| Projects in 2nd Reduced Program | 38.0 | 9.50 | 4.50 | 0.27 | 4.73 |
| | $ 53.0 | $13.30 | $4.50 | $0.54 | $8.26 |
| **Second Reduced Program** | | | | | |
| Park-and-Ride Lots | $ 16.8 | $4.20 | $ -- | $ -- | $4.20 |
| Passenger Information Aids | 3.2 | 0.80 | -- | 0.27 | 0.53 |
| Projects in 3rd Reduced Program | 18.0 | 4.50 | 4.50 | -- | -- |
| | $ 38.0 | $9.50 | $4.50 | $0.27 | $4.73 |
| **Third Reduced Program** | | | | | |
| Conventional Bus Replacement | $ 9.6 | $2.40 | $2.40 | $ -- | $ -- |
| Conventional Garage Renovation | 8.4 | 2.10 | 2.10 | -- | -- |
| | $ 18.0 | $4.50 | $4.50 | $ -- | $ -- |

Source: Columns (1) and (2) come from Table 5-1.

The lowest investment option (i.e., the third reduced program) includes only basic like-for-like replacements of the highest priority needed to run the system at the same operational quality and safety. The second reduced program option includes the basic replacement and renewal plan plus projects of high returns such as the park-and-ride lots and the passenger information aids programs. The highest option -- the first reduced program -- adds the passenger safety and amenities and the articulated bus program to the projects in the second reduced program. Projects with no effect on ridership are prioritized and grouped into program options along with capital projects with ridership impacts which have the same priority. Table 5-3 presents the annualized costs included in each of the options under consideration, as well as their revenue and trip generation impacts.

Recognition of Independence of Project Types

Analysis and groupings of capital projects for budgeting purposes must also recognize the degree of independence among projects. The following categories of projects reflect different degrees of mutual dependence:

i) independent projects -- are those for which acceptance of one project is not profoundly affected by the acceptance of other projects.

ii) mutually exclusive projects -- are those for which acceptance of one project renders others clearly unacceptable.

iii) contingent projects -- are those for which acceptance of one project is dependent on the acceptance of one or more other projects.

iv) compound projects -- are contingent projects combined with the projects on which they depend.

Examples of these project types may be provided. Bus replacement and staff safety projects are clearly independent of each other and may be analyzed in relative isolation of each other. That is, there is no requirement that independent projects be in the same program option. Acceptance of independent projects, in the absence of budget constraints, requires their net returns to be positive, thus:

$$(5.2)\quad \text{Net Returns} = \left(\frac{\text{Passenger Trips}}{\text{Passmark}}\right) + \left(\begin{matrix}\text{Adjusted}\\ \text{Revenues}\end{matrix}\right) - \left(\begin{matrix}\text{Adjusted}\\ \text{Annualized}\\ \text{Costs}\end{matrix}\right) > 0$$

Table 5-3: USA TRANSIT -- LOCAL SHARE COSTS AND IMPACTS OF THE PREFERRED INVESTMENT PROGRAM 1984-1988
(in millions of 1984 dollars, unless otherwise specified)

| | Total Non-Federal Costs (1) | ANNUALIZED NON-FEDERAL COSTS[a] | | | | Average Annual Revenues & Operating Cost Savings (6) | Average Annual Passenger Trips Generated (millions) (7) |
|---|---|---|---|---|---|---|---|
| | | All Projects (2) | Like-for-Like Replacement Projects (3) | Betterments and New Projects: Without Ridership Impacts (4) | Betterments and New Projects: With Ridership Impacts (5) | | |
| Articulated Buses | $ 3.0 | $ 0.40 | $ -- | -- | $0.40 | $0.13 | 0.30 |
| Conventional Bus Replacement | 2.4 | 0.32 | 0.32 | -- | -- | 0.66 | -- |
| Park-N-Ride Lots | 4.2 | 0.62 | -- | -- | 0.62 | 0.24 | 0.49 |
| Bus Station Improvements | 1.5 | 0.16 | -- | $0.16 | -- | -- | -- |
| Bus Radio and Communications | 0.7 | 0.17 | -- | 0.17 | -- | -- | -- |
| New Garage | 4.0 | 0.38 | -- | -- | 0.38 | 0.08 | 0.14 |
| Conventional Garage Renovation | 2.1 | 0.20 | 0.20 | -- | -- | -- | -- |
| Passenger Information Aids | 0.8 | 0.15 | -- | 0.02 | 0.13 | 0.02 | 0.16 |
| Staff Safety | 1.0 | 0.18 | -- | 0.18 | -- | -- | -- |
| Passenger Safety & Amenities | 0.8 | 0.15 | -- | 0.03 | 0.12 | 0.04 | 0.09 |
| Total | $20.5 | $2.73 | $ 0.52 | $0.56 | $1.65 | $1.17 | $1.18 |

Note:

[a]Interest rates and residual values of ten percent and the following service lives were assumed in the annualization of capital costs: 30 years for garages, 20 years for station improvements, 12 years for buses, ten years for park-n-ride lots, seven years for passenger information aids, passenger safety and amenities and staff safey programs and five years for bus radio and communication systems.

Sources: Column 1 comes from Table 5-1. Columns 2 through 5 come from annualizing Columns 2 to 5 in Table 5-2.

Mutually exclusive projects imply that acceptance of one project leads to rejection of the others. Decisions between selection of buses of different manufacturers involve deciding between mutually exclusive projects. Decisions in public bids for equipment purchase are also examples of mutually exclusive projects.[1] Selection between mutually exclusive projects involve accepting the project which provides for the most net returns, as estimated from Equation (5.2). Comparison and selection between mutually exclusive projects must precede the grouping of the selected project into the appropriate investment program option.

In the case of contingent projects, the dependence between the projects must clearly be recognized and the contingent or dependent project should appear in an investment program option of less priority than the independent project. For example, if the bus radio communication equipment is contingent on bus acquisition and replacement, the radio communications project should appear in an investment program option of less priority than the bus acquisition and replacement project.

Another possible approach to the evaluation of contingent projects is to combine the contingent project with the project on which it depends, and evaluate the independent project and the compound project as mutually exclusive alternatives. In the case above of the bus radio communications project, two projects would be defined: a bus replacement project without radio communications equipment versus a bus replacement project with radio communications equipment. As in the case of mutually exclusive projects, the alternative with the largest net returns would be chosen.

When projects have no direct or indirect effect on ridership, the capital budget acceptance criterion is to require a positive overall net financial return (i.e., positive net present values) after discounting the cash flows at the transit property's borrowing rate. For projects affecting ridership, the criterion of passenger trips per dollar of adjusted net revenues is used as a rationing device for matching projects and available funding. A passmark or marginal return of 0.785 passenger trips per dollar is used to screen less worthwhile projects, as described in Chapter 3.

---

[1]The decision on the appropriate frequency or headways options of Route 21 in the example presented in Chapter 4 also involved analysis of mutually exclusive policies.

## Analyzing Investment Program Options

Analysis of the investment options in terms of ridership and revenue impacts are presented in Table 5-4. As shown in this table the preferred investment program exceeds the capital budget ceiling and in addition is not economically feasible, since the passenger trips generated per dollar of net cost is below the passmark level of 0.785 passenger trips per dollar (see Chapter 3 for reference). Clearly, the preferred program should not be undertaken.

Grouping all projects of the same priority into programs permits analyzing the entire program in terms of the effects of the projects with ridership impacts. The reasoning is that since all the projects in the program have comparable priority, the effectiveness results in terms of passenger miles per dollar of net cost of the projects with ridership impacts apply as well to all the projects in the program groups. Moving from one reduced program to another has an impact on the income (or revenue) accounts, as cost savings are foregone or postponed and revenue increments are lost. Also ridership is impacted as service improvements are postponed or quality declines due to the non-replacement of equipment when moving from one program to another of less priority. Incremental changes between investment program options are analyzed in Table 5-5.

The first reduced program is economically feasible, since its incremental returns in terms of passenger trips per dollar of net cost exceed the passmark level. Adoption of the first reduced program would maximize ridership since its marginal effect of 1.114 passenger trips per dollar of net cost exceeds the passmark level. However, the first reduced program exceeds the capital budget constraint of $10 million of local share funding for the five-year program.

The second reduced program meets the capital budget constraint. It also achieves the highest average passenger trips per dollar of net cost. However, ridership and benefits are not maximized by adoption of this program. Comparisons of the net returns (in millions of 1984 dollars) for the first and second reduced programs are as follows:

Table 5-4: UBA TRANSIT -- ANALYSIS OF INVESTMENT PROGRAM OPTIONS 1984-1988
(in millions of 1984 dollars, unless otherwise specified)

| Investment Program Options | Total Capital Costs: Federal Share (1) | Total Capital Costs: Local Share (2) | Adjusted Annualized Capital Costs (3) | Adjusted Average Annual Net Operating Revenues (4) | Adjusted Average Annual Net Costs (5)=(3)-(4) | Average Annual Passenger Trips Generated (Millions) (6) | Average Annual Passenger Trips Per Dollar of Adjusted Net Costs (7)=(6)÷(5) |
|---|---|---|---|---|---|---|---|
| Preferred Program | | | | | | | |
| New Garage | $16.0 | 4.0 | $0.38 | 0.08 | $0.30 | 0.14 | 0.467 |
| Bus Stations Improvements | 6.0 | 1.5 | 0.16 | — | 0.16 | — | 0 |
| Bus Radio & Communications | 2.8 | 0.7 | 0.17 | — | 0.17 | -- | 0 |
| Staff Safety | 4.0 | 1.0 | 0.18 | — | 0.18 | -- | |
| Projects in 1st Reduced Program | 53.0 | 13.3 | 1.84 | 1.09 | 0.75 | 1.04 | 1.387 |
| | $81.8 | $20.5 | $2.73 | 1.17 | $1.56 | 1.18 | 0.756 |
| First Reduced Program | | | | | | | |
| Articulated Buses | $12.0 | $ 3.0 | $0.40 | $0.13 | $0.27 | 0.30 | 0.900 |
| Passenger Safety & Amenities | 3.8 | 0.8 | 0.15 | 0.04 | 0.11 | 0.09 | 0.818 |
| Projects in 2nd Reduced Program | 38.0 | 9.5 | 1.29 | 0.92 | 0.37 | 0.65 | 1.757 |
| | $53.8 | $13.3 | $1.84 | $1.09 | $0.75 | 1.04 | 1.387 |
| Second Reduced Program | | | | | | | |
| Park-N-Ride Lots | $16.8 | $ 4.2 | $0.62 | $0.24 | $0.38 | 0.49 | 1.289 |
| Passenger Information Aids | 3.2 | 0.8 | 0.15 | 0.02 | 0.13 | 0.16 | 1.231 |
| Projects in 3rd Reduced Program | 18.0 | 4.5 | 0.52 | 0.66 | -0.14 | — | 0 |
| | $38.0 | $ 9.5 | $1.29 | $0.92 | $0.37 | 0.65 | 1.757 |
| Third Reduced Program | | | | | | | |
| Conventional Bus Replacement | $ 9.6 | $ 2.4 | $0.32 | $0.66 | $-0.34 | -- | Not Defined |
| Conventional Garage Renovation | 8.4 | 2.1 | 0.20 | — | 0.20 | -- | 0 |
| | $18.0 | $ 4.5 | $0.52 | $0.66 | $-0.14 | -- | Not Defined |

Note: The estimation of the adjusted annual net costs (Column 5) maintains the assumption made in Chapter 3 of required operating subsidy levels exceeding the cap on Federal operating subsidies. Therefore no adjustments for the effect of Federal operating subsidies are required.

Sources: Columns (1) and (2) come from Table 5-1; Column (3) comes from Table 5-3 (Column 2); Column (4) comes from Table 5-4 (Column 6); and Column (6) comes from Table 5-3 (Column 7).

Table 5-5: USA TRANSIT -- ANALYSIS OF INCREMENTAL CHANGES BETWEEN PROGRAM OPTIONS 1984 - 1988
(in millions of 1984 dollars, unless otherwise specified)

| Investment Program Options: Programs | Investment Program Options: Project Types | Adjusted Annualized Non-Federal Capital Costs (1) | Revenues and Operating Cost Savings Generated (2) | Average Annual Passenger Trips Generated (millions) (3) | Average Annual Passenger Trips Per Dollar of Adjusted Net Costs (4)=(3) ÷ [(1)-(2)] |
|---|---|---|---|---|---|
| Preferred Program | All Projects | 2.73 | $1.17 | 1.18 | 0.756 |
| | Projects with Ridership Impacts | 1.65 | 0.51 | 1.18 | 1.035 |
| 1st Reduced Program | All Projects | 1.84 | 1.09 | 1.04 | 1.387 |
| | Projects with Ridership Impacts | 1.27 | 0.43 | 1.04 | 1.238 |
| 2nd Reduced Program | All Projects | 1.29 | 0.92 | 0.65 | 1.757 |
| | Projects with Ridership Impacts | 0.75 | 0.26 | 0.65 | 1.326 |
| 3rd Reduced Program | All Projects | 0.52 | 0.66 | 0.00 | Not Defined |
| | Projects with Ridership Impacts | 0.00 | 0.00 | 0.00 | Not Defined |
| Incremental Changes Between Options: | | | | | |
| Cut from preferred to 1st reduced program | All Projects | $0.89 | $0.08 | 0.14 | 0.173 |
| | Projects with Ridership Impacts | 0.38 | 0.08 | 0.14 | 0.467 |
| Cut from 1st reduced to 2nd reduced program | All Projects | 0.55 | 0.17 | 0.39 | 1.026 |
| | Projects with Ridership Impacts | 0.52 | 0.17 | 0.39 | 1.114 |
| Cut from 2nd reduced to 3rd reduced program | All Projects | 0.77 | 0.26 | 0.65 | 1.275 |
| | Projects with Ridership Impacts | 0.75 | 0.26 | 0.65 | 1.326 |

Note: Some projects such as the passenger information aids and the passenger safety and amenities, include components with and without ridership impacts. See Table 5-3.

Source: See Tables 5-3 and 5-4.

| | Passenger Trips ÷ Passmark[a] (1) | Adjusted Net Operating Revenues[b] (2) | Adjusted Annualized Capital Costs[c] (3) | Net Returns (4)=(1)+(2)-(3) |
|---|---|---|---|---|
| First Reduced Program | | | | |
| All Projects | 1.32 | $1.09 | $1.84 | + 0.57 |
| Projects with Ridership Impacts | 1.32 | 0.43 | 1.27 | + 0.48 |
| Second Reduced Program | | | | |
| All Projects | 0.83 | 0.92 | 1.29 | + 0.46 |
| Projects with Ridership Impacts | 0.83 | 0.26 | 0.75 | + 0.34 |

[a]Evaluated at the passmark level of 0.785 passenger trips per dollar of adjusted net revenues.

[b]Adjusted revenues are identical to revenues in this case, since USA Transit's required operating subsidies exceed the Federal cap on operating subsidies.

[c]Adjusted annualized capital costs correspond to the annualized non-Federal costs.

While the second reduced program is economically feasible since its marginal returns exceed the passmark level, the maximum net return option is the first reduced program. Since the first reduced program exceeds the passmark level, it is preferable to raise fares (or to not cut fares by a level as large as shown in Chapter 4) to undertake this program, given that it is superior to the fare change option.

A major result of the capital program is that some capital projects need to be deferred. In deciding on deferments of capital investments, the direct loss of benefits by undertaking the project at a later date has to be considered along with the effect on future investment programs of including the project in later years. If the availability of capital funds is very restrictive in later years, then the initial decision to defer a good project will have effects that go on for very many years. If capital availability in future years is less restrictive, then the effects of deferment will be reduced.

The choice for the Transit Board is: Do they accept an economically feasible program (i.e., the second reduced program) which is within the budget constraints or do they accept a superior option (i.e., the first reduced program) which also involves fare changes? On strictly economic terms the first reduced program should be adopted and fares raised (or fare cuts limited to levels above the fare reduction recommended in Chapter 4). However, in the highly political environment surrounding fare changes, factors other than the economic impacts need to be taken into consideration. Only the Board can incorporate the political factors in the final decision.

Submission of the five-year Investment Program provides a management control focus while displaying the bids for resources made by the capital projects under consideration. The five-year Investment Program also brings to focus decisions regarding the overall allocation of resources between operating and capital funds by indicating an optimum split between these two uses of funds.

### Developing the Cash Flow Projections

The final task in the financial analysis of capital budgets is to estimate the financial requirements of the five-year Investment Program in terms of short-term and long-term funds that need to be borrowed. Assuming that the second reduced Investment Program is selected by the Transit Board, Table 5-6 displays the cash flow projections incidental to that program including short-term and long-term financing requirements. In this case, the need for significant capital investments in the period after 1987 makes it necessary to float bonds in early 1987. Previous to that time short-term loans and state operating assistance are used to take care of short-term cash flow needs.

## MARKET RESEARCH AND MONITORING FARE CHANGES

Implementation of a successful transit corporate planning procedure requires both constant monitoring of fare changes to estimate changes in fare elasticities as well as conducting the necessary market research to ascertain the effect of capital investment projects on ridership.

Fare elasticities affect the passmark value, and therefore changes in fare elasticities need to be monitored. This should be done by first collecting and analyzing in a regular fashion raw data on ridership "before" and "after" a fare change. Elasticities would then be estimated for the aggregate system and by user groups, if required.[1] The estimation of elasticities would be supplemented with user surveys to explain the ridership response.

---

[1] Michael Kemp. Planning for Fare Changes: A Guide for Interpreting and Using Fare Elasticity Information for Transit Planners. The Urban Institute Working Paper 1428-05, December 1980.

Table 5-6: USA TRANSIT — CASH FLOW PROJECTIONS FOR THE FIVE-YEAR INVESTMENT PROGRAM
(millions of 1984 dollars)

| | 1984 | | | | | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|
| | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | Total | | | | |
| A. Cash In-Flow -- Total | $1.74 | $4.81 | $1.63 | $12.72 | $20.90 | $17.89 | $26.24 | $34.70 | $35.13 |
| 1. Revenues - Total | 1.74 | 4.21 | 1.63 | 7.32 | 14.90 | 14.66 | 16.74 | 16.50 | 19.63 |
| Fare Revenues | 1.70 | 1.62 | 1.59 | 1.55 | 6.46[a] | 6.65 | 7.31 | 7.52 | 8.27 |
| Federal Operating Assistance[b] | 0.00 | 0.00 | 0.00 | 3.19 | 3.19 | 2.55 | 1.91 | 1.27 | 0.63 |
| State Operating Assistance | 0.00 | 2.54 | 0.00 | 2.53 | 5.07 | 5.27 | 7.32 | 7.50 | 8.60 |
| Interest from Undistributed Portion of Long-Term Bonds | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.90 |
| Other Revenue | 0.04 | 0.05 | 0.04 | 0.05 | 0.18 | 0.19 | 0.20 | 0.21 | 0.23 |
| 2. Capital Assistance - Total | 0.00 | 0.60 | 0.00 | 5.40 | 6.00 | 2.50 | 9.50 | 16.00 | 13.50 |
| Federal Assistance (80%) | 0.00 | 0.00 | 0.00 | 4.80 | 4.80 | 2.00 | 7.60 | 12.80 | 10.80 |
| State and Local Assistance | 0.00 | 0.60 | 0.00 | 0.60 | 1.20 | 0.50 | 1.90 | 3.20 | 2.70 |
| 3. Short-Term Loans[c] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.73 | 0.00 | 0.00 | 0.00 |
| 4. Long-Term Bonds (Portion distributed during period)[d] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.20 | 2.00 |
| B. Cash Out-Flow -- Total | 3.39 | 3.35 | 6.28 | 6.25 | 19.27 | 16.30 | 23.85 | 31.35 | 30.07 |
| 1. Operating Costs | 3.39 | 3.35 | 3.28 | 3.25 | 13.27 | 13.80 | 14.35 | 15.35 | 16.57 |
| 2. Investment Capital Costs (Second Reduced Program) | 0.00 | 0.00 | 3.00 | 3.00 | 6.00 | 2.50 | 9.50 | 16.00 | 13.50 |
| C. Cash Flow Before Debt Service C=(A-B) | ($1.65) | 1.46 | ($4.65) | 6.47 | 1.63 | 1.59 | 2.39 | 3.35 | 5.06 |
| D. Debt Service - Total | 0.00 | 0.00 | 0.00 | 1.59 | 1.59 | 1.59 | 2.39 | 1.59 | 3.69 |
| 1. Interest on Short-Term Loans | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.00 |
| 2. Interest on Long-Term Bonds | 0.00 | 0.00 | 0.00 | 1.59 | 1.59 | 1.59 | 1.59 | 1.59 | 3.69 |
| 3. Prepayments of Short-Term Loans | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.73 | 0.00 | 0.00 |
| 4. Prepayments of Long-Term Loans | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| E. Net Cash Flow After Debt Service E=(C-D) | ($1.65) | 1.46 | ($4.65) | 4.88 | 0.04 | 0.00 | 0.00 | 1.76 | 1.37 |
| F. Cash Balance, End of Period | $ 3.56 | $5.02 | $0.37 | $5.25 | $5.29 | $5.29 | $5.29 | $7.05 | $8.42 |

[a]Includes implementation of the fare (-25%) and service (-25.3%) reductions analyzed in Chapter 4.

[b]Assumes elimination of Federal operating assistance by 1989.

[c]Short-term (12 months) loan at 10% interest rates.

[d]Long-term bonds for $20 million at 10% interest and 30-year maturity were issued in 1987.

Source: Hypothetical projections summarizing the information presented in Tables 3-3, 4-1, and 5-5.

A review of the evidence of changes in ridership generated by changes in services shows that not much is known about the effect on ridership of several capital projects.[1] Most capital projects affect ridership indirectly through changes in wait times and/or headways. If a determination can be made of the effect of capital projects on these demand factors, then the ridership response can be predicted within some ranges. The problem is when the capital project does not affect wait times and/or headways, or when it is impossible to trace the effect of the capital project on the service factors affecting demand. In this case conducting market research activities becomes obligatory. Therefore, it becomes necessary to survey usage of renovated stations or shelters if the effects on ridership of station renovation or of provision of shelters is to be estimated for the capital budget exercise.

Some transit properties in America maintain market research departments but their function so far has been mainly to research fare promotions, advertising themes, etc. The advent of transit corporate planning will require marketing departments to expand the scope of the marketing research to encompass the effect on ridership of capital projects.

## CONCLUSIONS

This report addresses transit corporate planning techniques to improve the management and financing of transit services and in planning investment expenditures in transit investments.

The essence of the transit corporate plan is the process of planning and decision-making, of adopting corporate objectives which reflect the public service aims of transit service, of evaluating alternatives and of developing standards to balance the revenue and capital needs of transit operations. Transit corporate planning techniques, some borrowed from European practice, are ready to be experimented and demonstrated in American transit settings. There is hope that the next few years will witness increased interest and the actual implementation of these corporate planning concepts and techniques.

---

[1]Armando M. Lago, Patrick D. Mayworm, and J. Mathew McEnroe. "Transit Service Elasticities." Journal of Transport Economics and Policy. May 1981.

BIBLIOGRAPHY


Alter, Colin H. "Evaluation of Public Transit Services: The Level of Service Concept." Transportation Research Record No. 606. 1976.

American Public Transit Association. "Revised Policy Statement, Transit Performance," approved by the Board of Directors, February 17, 1979.

Anderson, Shirely C. and Gordon J. Fielding. Comparative Analysis of Transit Performance. Institute of Transportation Studies. University of California, Irvine, California, January 1982.

Argenti, Jonn. Practical Corporate Planning. London, Boston: G. Allen & Irwin. 1980.

Beesley, Michael E. Urban Transport: Studies in Economic Policy. Butterworths. London, 1973.

Bonnell, J.R. "Transit's Growing Financial Crisis." Traffic Quarterly. Vol. 35, No. 4, October 1981.

Botzow, Herman. "Level of Service Concept for Evaluating Public Transport." Transportation Research Record No. 519. 1974.

Cherwony, W. and M.G. Ferreri. "Strategic Planning as a Transit Management Tool." Transportation Research Record No. 797. 1981.

Denning, Basil W. Corporate Planning: Selected Concepts. London, New York, McGraw-Hill. 1971.

Ecosometrics, Inc. Patronage Impacts of Changes in Transit Fares and Services. Prepared for the Urban Mass Transportation Administration. Office of Service and Methods Demonstrations. Bethesda, Maryland. September 1980.

Ecosometrics, Inc. A Manual for Planning and Implementing a Fare Change. Prepared for the Urban Mass Transportation Administration. Office of Service and Methods Demonstrations. Bethesda, Maryland. August 1981.

Glaister, S. and J.J. Collings. "Passenger Miles Maximization in Theory and Practice." Journal of Transport Economics and Policy. Vol. XII. No. 3. September 1978.

Holec, James M., Dianne S. Schwager, and Angel Fandalian. "Use of Federal Section 15 Data in Transit Performance: The Michigan Program." Transportation Research Record No. 746. 1981.

Hussey, David E. Corporate Planning Theory and Practice. Second Edition, Oxford, New York. Pergamon Press, 1982.

Kirby, Ronald F. and Melinda A. Green. "Policies and Procedures for Transit Service Development." Traffic Quarterly. Vol. 33, No. 3, July 1979.

Lago, Armando M., Patrick D. Mayworm, and J.M. McEnroe. "Transit Ridership Responsiveness to Fare Changes." Traffic Quarterly. Vol. 35, No. 1, January 1981.

Lago, Armando M. and Patrick D. Mayworm. "Transit Means Business: A Corporate Planning Approach to Transit Fare and Service Planning." Traffic Quarterly. Vol. 36, No. 3, July 1982.

Lago, Armando M., Patrick D. Mayworm, and J.M. McEnroe. "Transit Service Elasticities." The Journal of Transport Economics and Policy. Vol. XVII, No. 2, May 1981.

London Transport Executive Business Planning Office. "London Transport's Corporate Aim Explained." London, England. 1975.

London Transport Executive. "London Transport's Corporate Aim." London, England, 1977 (mimeo).

Lyneis, James M. Corporate Planning and Policy Design: A System Dynamics Approach. Cambridge, Massachusetts, MIT Press, 1980.

Miller, James H. "The Use of Performance-Based Methodologies for the Allocation of Transit Operating Funds." Traffic Quarterly. Vol. 34, No. 4, October 1980.

Miller, J.H. "An Evaluation of Allocation Methodologies for Public Transportation Operation Assistance. Transportation Journal. Vol. 19, 1979.

Nash, C.A. "Management Objectives, Fares and Service Levels in Bus Transport." Journal of Transport Economics and Policy. Vol. XII, No. 1, January 1978.

National Committee on Urban Transportation. Better Transportation for Your City. Procedure Manual 4A: Measuring Transit Service. Public Administration Service. Chicago, Illinois, 1958.

National Committee on Urban Transportation. Better Transportation for Your City. Procedure Manual 8A: Recommended Standards, Warrants and Objectives for Transit Services and Facilities. Public Administration Service. Chicago, Illinois, 1958.

Organization for Economic Cooperation and Development. Managing Transport: Management of Transport Systems to Improve the Urban Environment. Paris, France, 1979.

Public Technology Inc. Proceedings of the First National Conference on Transit Performance. Prepared for the Urban Mass Transportation Administration. Washington D.C., 1978.

Quarmby, D.A. "Investment Planning in London Transport Using Non-Financial Criteria -- Part I." Journal of Enterprise Management. Vol. I, 1978.

Radford, K.J. Strategic Planning: An Analytical Approach. Reston, Virginia, Reston Publishing Company, 1980.

U.S. General Accounting Office. Soaring Transit Subsidies Must Be Controlled. Report CED-81-28. Washington, D.C., February 26, 1981.

Wachs, Martin. "Pricing Urban Transportation: A Critique of Current Policy." Journal of the American Planning Association. Vol. 47, 1981.

Wagon, D.J. "Resource Allocation for Bus Service Planning." London Transport Executive. Operational Research Report R 221. London, England. July 1976.

Weingartner, H. Martin. Mathematical Programming and the Analysis of Capital Budgeting Problems. Prentice Hall Inc. Englewood Cliffs, New Jersey, 1965.

Whitley, M. "Optimizing Public Transport Performance - The London Method." Symposium on Integrating Public Transport. Newcastle University, 1977.

# NOTICE



**DOT-I-87-12**

TECHNOLOGY SHARING

A Program of the U.S. Department of Transportation