

28. Calculate the annual reserve for depreciation by multiplying the total fleet size (item 16) by the capital replacement or depreciation reserve costs (item 19).

29. Calculate the total deficit by adding the annual operating deficit (item 27) and the annual reserve for depreciation (item 28).

The introduction of a new transit service also involves special one-time-only costs. These can be calculated by the following procedures.

30. Calculate the market-introduction costs by estimating losses of 40 and 50 percent, respectively, of the annual revenue (item 26) for fixed-route and dial-a-bus services and savings of 15 percent of the annual operating cost (item 25).

31. Calculate the design costs by adding the estimated costs of a feasibility study (\$20 000), a detailed design study (\$15 000), implementation (\$20 000), and monitoring (\$20 000).

32. Calculate the cost of buses on the basis of the bus selected (item 9) by multiplying the total fleet size (item 16) and the current prices (item 19).

33. Estimate the costs of garage facilities and communications equipment.

34. Calculate the total capital required by adding the bus cost (item 32) and the costs of garage facilities and communications equipment (item 33).

For wage rates and cost components other than those used above, the calculations can be adjusted by the following procedures. The cost of operators' wages (item

21) can be calculated by multiplying the annual vehicle hours of service by $(9.25/6.95)$ times the different wage rate. The transportation operating cost (item 22) can be calculated by multiplying the vehicle kilometers of service by $(0.22 \times 0.35/7.60)$ times the different mechanics' wage rate and adding this to $(\$0.22 \times 0.25 \times \text{the percentage increase in fuel costs})$ plus $(\$0.22 \times 0.40)$.

Other adjustments that can be made to the basic calculation procedure include the following:

Privately owned systems generally have lower fringe costs than do municipally operated systems. For such systems, the basic rates for operators' wages (item 21) and transportation operating cost (item 22) may be reduced to \$8.00/h and \$0.20/km (\$0.32/mile), and the cost of dispatching and clerical services may be reduced by 25 percent.

If the system is operated on Sundays and holidays, the fleet operating hours (item 11) and distance (item 13) can be increased by 12 percent for 8 h of service. If the system is operated for more than 12 h of Monday-Saturday service, the fleet operating hours (item 11) and distance (item 13) can be increased by 7 percent for each hour of service after 7:00 p.m.

Readers of Atkinson's paper should be cautioned that the techniques discussed were not calibrated for U.S. conditions although they may be applicable to small cities in the Pacific Northwest. In general, subsidies per capita are much higher for small Canadian systems than for U.S. systems.

A Vital Phase of Transit Evolution: Management Information Systems

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Passage of the Urban Mass Transportation Act of 1964 signaled a new era for the transit industry by facilitating the public acquisition of private operations as well as capital purchases of equipment. In 1974, operating assistance was provided under the National Mass Transportation Act. The increase in federal funding, however, has resulted in significant increases in federal regulations and reporting requirements. This has caused an intensive effort to provide sound system management and internal controls at the local level. To give transit managers the information essential to fully utilize available funds, management information systems have been developed. Successful management information systems are based on, first, the identification of the particular information needs of a transit system and, second, the development of performance criteria from an in-depth statistical analysis of the management provided. Although the management information systems are continually being updated, the performance criteria are still in the formative stages. Yet it is these performance criteria, based on sound management information, that will help transit to become more cost-effective and to provide better service.

Over the past 15 years, the transit industry has been experiencing a renaissance, an attempt to restore a once vital service back to the level of prominence that it enjoyed during World War II. This revitalization, however, is prompted by more than nostalgia. What is emerging today is a new and dynamic, highly marketable public service that can be geared to every phase of urban life.

This renaissance can be divided into five development phases. The first phase began with the passage of the Housing and Urban Development Act of 1961, which provided grants for demonstrations and loans for projects and made transit planning part of the urban planning process. The Urban Mass Transportation Administration (UMTA) was born in the Department of Housing and Urban Development in recognition of the problems the transit industry was facing and the realization of the role transit could play in the revitalization of the cities. The second phase coincides with the enactment of the Urban Mass Transportation Act of 1964. The third phase was made possible by the National Mass Transportation Assistance Act of 1974, which substantially strengthened the previous financial commitments and initiated the provision of operating assistance for transit. These federal funds began a physical rehabilitation throughout the country. But inherent with the provision of tax dollars, the third phase included the development of federal regulations and accountability. The fourth phase has been the most difficult phase to cope with to date. Once federal funding and federal reporting became routine conditions, it became necessary to develop sound system management and internal control at the local level. Gaining control of systems or depart-

ments that had been chaotic for years appeared at times to be a herculean task. This control is necessary, however, if the desired ends are to be met. To provide the transit manager of today the answers essential to optimum utilization of the available funds, management information systems (MISs) are necessary. It is only through the vigorous, although sometimes tedious, identification of the information needs of a transit system that an effective management information system can be developed, and it is only after these needs have been identified that the fifth phase can begin. The development of performance criteria occurs as a result of in-depth statistical analyses of the information the MIS provides. These performance criteria then become standards on which to evaluate subsequent performance. This paper will briefly review the first three phases of the transit renaissance, then take a close look at the fourth, and finally examine the basic steps required to develop an MIS for a current transit system.

REVIEW OF PHASES 1, 2, AND 3

When President Lyndon Johnson signed the 1964 act, a new era dawned for the urban transit industry. The enactment of this bill initiated a monumental effort to transform what had once been a profitable private enterprise into a functioning public service in an age where abundant, inexpensive transportation had become implicit in the life of urban America. At that time, it hardly seemed prudent to use tax dollars in an attempt to save an industry that was dying a slow death. Transit systems, once the main arteries of our metropolitan areas, were in a sad state of disrepair. The spiraling economic losses in the transit industry had led to fatal cutbacks of all functions. Sagging profits had caused postponement of routine equipment maintenance. The poor financial picture had caused fare increases and service reductions that compounded the problem of dwindling ridership. Operational facilities resembled junk yards, housing cannibalized buses and inoperative equipment and breeding untenable working conditions.

The 1964 act facilitated the public acquisition of private operations and capital purchases of new equipment. Cleaner, newer buses were soon on the streets. Operational facilities were rehabilitated and new ones were built. Working conditions quickly improved, and a new breed of transit professionals began to emerge. For the first time in decades, transit management became recognized as a promising career. And this trend has continued. Additional impetus was provided when the 1974 act first provided operating assistance (although the influx of federal dollars has been accompanied by a dramatic increase in federal regulation and accountability). These facets of phase 3 have become an integral part of transit management in the past 15 years and will inevitably continue to increase in importance.

A LOOK AT PHASE 4

The creation of the Industry Control Board to aid in the development of the reporting elements of Section 15 of the 1964 act, as amended 1974, was a result of the need to provide a uniform financial and statistical reporting system on an industrywide basis.

The special needs of the mobility disadvantaged have also been addressed through federal regulations. The requirement of a half fare for the elderly and the handicapped was the first step, and development of coordinated dial-a-ride systems has become commonplace. Most cities have responded to these needs by earmarking 5 percent of transit funds for projects specifically designed to facilitate transportation for the elderly and the

handicapped. The Transbus specifications pay great attention to the needs of the mobility disadvantaged.

Title VI of the Civil Rights Act of 1964 and Minority Business Enterprise and Equal Employment Opportunity programs attempt to prevent discrimination as to the service provided; reduce the artificial, incidental barriers to full participation of minority businesses in the economy; and provide for equitable distribution of employment opportunities. However, most of these regulations dictate tangible standards that must be met to maintain eligibility for federal funding. Little, if any, operational benefit can be derived from meeting or exceeding these standards, but only after they are met and maintained, can attention be directed toward the day-to-day operation.

BASIC STEPS IN DEVELOPING A MANAGEMENT INFORMATION SYSTEM

Effective system management and internal control consists of three elements: a comprehensive MIS, timely accumulation of data, and performance evaluation against prescribed standards. Lack of any of these will hamper the overall effectiveness of the system. Phase 4 began with the introduction of the new breed of transit professional to the management level. Old questions were asked, but no longer were the old answers adequate. New questions were asked that had no answers. Massive amounts of information demands were not being met. Clearly, an information system was required to meet the demand.

However, all information has some cost. More so now than ever before, we have cost-effectiveness and cost scrutiny on our minds. Consequently, the initial step in the development of an MIS is an identification of information needs. The following information is commonly available to the transit manager:

Number of accidents	Number of revenue passengers
Number of bus defects	Number of revenue vehicles
Coverage area	Number of revenue vehicle hours
Population of coverage area	Number of revenue vehicle kilometers
Transit-dependent population of coverage area	Number of road calls
Energy consumption	Number of route kilometers
Fare-box revenues	Service area
General administration expenses	Population of service area
Number of linked passenger trips	Transit-dependent population of service area
Linked trip distance	Total number of passengers
Number of maintenance employees	Total number of passenger kilometers
Maintenance expenses	Total revenue
Maintenance labor hours	Number of transfer passengers
Operating expenses	Number of unlinked passenger trips
Operations expenses	Unlinked trip distance
Number of originating passengers	Number of vehicle kilometers
Number of revenue capacity hours	
Number of revenue capacity kilometers	

The next step entails listing and combining this information into a logical format. This requires a specific identification of the particular information (either currently available or not) that could provide meaningful data relevant to the ongoing operation. Once the data elements have been determined, a logical format must be designed to report the information. Some commonly used data elements and their frequency of reporting are listed in Table 1.

The MIS reports represent the final products of the initial MIS development plan. First, the information needs were determined by management. An evaluation was conducted to determine the information that is essential to effective management, and this was followed

Table 1. Data elements for management information systems.

Data Element	Frequency
Number of revenue vehicle kilometers per revenue vehicle	Annually
Number of revenue capacity kilometers per revenue vehicle	Annually
Number of revenue vehicles per maintenance employee	Annually
Number of maintenance labor hours per revenue vehicle	Annually
Ratio of number of revenue passengers to population of service area	Annually
Ratio of population of coverage area to population of service area	Annually
Total operating expense per revenue vehicle kilometer	Monthly
Total maintenance expense per revenue vehicle kilometer	Monthly
Energy consumption per revenue vehicle kilometer	Monthly
Energy consumption per vehicle kilometer	Monthly
Number of road calls per revenue vehicle	Monthly
Number of road calls per revenue vehicle kilometer	Monthly
Operating expense per linked passenger trip	Monthly
Ratio of fare-box revenue to number of revenue passengers	Monthly
Ratio of total revenue to operating expenses	Monthly
Fare-box revenue per revenue vehicle kilometer	Weekly
Fare-box revenue per revenue vehicle hour	Weekly
Number of revenue passengers per revenue vehicle kilometer	Weekly
Number of linked passenger trips per revenue vehicle kilometer	Weekly
Number of unlinked passenger trips per revenue vehicle kilometer	Weekly
Number of revenue passengers per revenue vehicle hour	Weekly
Number of linked passenger trips per revenue vehicle hour	Weekly
Number of unlinked passenger trips per revenue vehicle hour	Weekly
Number of revenue vehicle kilometers per route per day	Weekly
Number of revenue vehicle hours per route per day	Weekly

by compilation of the data elements into a logical format. The final report formats and reporting periods were reviewed by management for approval.

After the final approval of the management information product, the raw data required to generate the reports were identified. These include items such as fare-box reports (or trip sheets), daily operations reports, road-calls reports, and operator payroll information. During this editing phase, much of the available raw information is determined to be nonessential to the final product. These data should be eliminated because the generation of information that is not used is an inefficient use of resources.

Normally, the raw data are processed to determine the intermediate data. Computerized processing is possible but not essential for the generation of these intermediate data. Intermediate reports can be prepared manually if the costs incurred by computerization are too high. At this point, the emphasis should be on fundamental data accumulation. The MIS development schedule is summarized below:

1. Identification of management information needs,
2. Determination of essential requirements,
3. Definition of final products,
4. Identification of essential raw data,
5. Development of procedures for processing the raw data to the final report,
6. Implementation and debugging, and
7. Reevaluation and updating.

Once the data-processing methods have been identified, the MIS should be ready for implementation. The implementation phase usually requires the greatest perseverance. No system design has ever been perfect. Errors will be abundant, and faults in the system will require immediate attention. After a short time, however, the MIS should be fully operational and providing management with appropriate information. At this point, the MIS should not be accepted as completely functional. A critical evaluation of the entire system should be undertaken, reevaluating every phase of development. Inefficiencies in operations and deficiencies in reporting must be identified and resolved. Additional reporting requests should be examined for possible adoption. This

ever-present reevaluation and subsequent updating are essential if the MIS is to maintain its responsiveness to the needs of management. Without it, the MIS will become outdated.

When the MIS is fully operational, the information it generates about the transit operation must be evaluated against specific performance standards. Few transit systems are identical. What would represent valid ridership for New York City would hardly be valid for Fort Worth. Standards for each operator should be set locally based on history and then periodically updated. The transit renaissance has brought about many changes since 1961. Transit ridership nationwide is increasing, and federal support appears secure. Working conditions are greatly improved. The first several phases of this change are well established. Management systems and internal control are now approaching the forefront in the transit industry. Shortly, the first Section 15 reports will be submitted to the Urban Mass Transportation Administration. State transportation departments, metropolitan planning organizations, and local transit operators are attempting to coordinate their information requirements. New MIS systems are being developed, and others are being updated. Performance criteria are still in the formative stages. Through effective reporting and analysis of pertinent and timely managerial information, the current changes in transit will continue, despite inflation, tax cuts, and emphasis on cost-effectiveness and cost scrutiny.

A good management information system (MIS) must be flexible and adaptable because service types, fare structures, vehicle types, and labor agreements can change. In addition, a good system should require a minimum of periodic input data.

In the transit system in Fort Worth, Texas, 85 percent of the MIS data was handled manually before the computerized system was installed. However, the computerized system is estimated to have saved 2.5 full-time administrative positions. In the transit system in Boise, Idaho, one clerk is able to prepare all of the MIS reports manually for 26 transit coaches and six dial-a-bus vehicles. The general conclusion of the workshop participants was that smaller transit systems can use computerized MISs if several small properties can jointly establish a time-shared mini-computer-based system.