Abridgment

Automation in Public Transit Operation and Management: Trends and Prospects

MICHAEL R. COUTURE AND GRANVILLE E. PAULES

Managers in the public transit industry are exploiting automated data processing (ADP) techniques in their efforts to measure and improve operating performance. Important ADP innovations are highlighted in this discussion; they are followed by a sketch of prospects for the future. The desirable integrating nature of ADP processes is suggested as an important means for structuring the flow of management information. Service planning and its complexities receive some comments. The Urban Mass Transportation Administration's support and research areas are summarized.

Faced with increasingly high operating costs and greater accountability as well as demands for more and better service, the highly visible public transit industry needs responsive, cost-effective tools to aid in systems management. In response, transit agencies have turned increasingly to automated data processing (ADP) methods for assistance in collecting, organizing, and analyzing transit system information.

A major factor that supports this trend has been the increased reporting requirements (and therefore data collection and processing requirements) mandated by Section 15 of the Urban Mass Transportation Act of 1964. No small incentive is provided by the Section 3 assistance for developing automated reporting systems. In addition, generally increased awareness by transit industry personnel of ADP methods has helped. The evolution of low-cost minicomputer and microcomputer technology has further encouraged operators to obtain or update data processing systems.

CURRENT APPLICATIONS

Uses of ADP methods have varied greatly; they depend primarily on the size and presence (or lack) of staff that accepts ADP processes. However, with many of the cost barriers now removed, there is an increasing commitment to automated systems by transit agencies of all sizes. To provide some perspective, several particularly innovative systems are noted here.

At the Chicago Transit Authority, a sophisticated on-line maintenance management system has been in use for several years. Its functions include reporting road calls and defects, scheduling preventive maintenance, monitoring vehicle availability, analyzing repair history, and evaluating maintenance-employee performance. This system has been used as a model for other agencies that have developed maintenance management information systems (MIS). Seattle's Metro is developing an on-line MIS that uses a powerful data-base management system to support a variety of functions that include route planning, scheduling and costing, payroll and personnel accounting, inventory controlling, and vehicle operations monitoring. Portland Tri-Met's comprehensive on-line maintenance management system is implemented on a minicomputer. For small transit agencies, perhaps the most-significant development is a first-generation general-purpose MIS, marketed as TRANS-PAC by MTD Project Services of Seminole, Florida. Implemented on a desk-size minicomputer, this system provides payroll support and operations and maintenance management data and outputs statistics required by Section 15. It can be easily installed at any small agency that has from 20 to 250 vehicles and is currently in operation at several agencies in Florida and at least one in California.

Automated data entry methods are becoming increasingly popular. Applications include on-line fuel meters (Dallas), passenger counters (Seattle), and fare boxes (Ft. Wayne) that have computer interfaces, employee data from identification cards (Chicago, Portland, Flint, and Nashville), and monitors of vehicle position and status (Cincinnati).

Long-range transit systems planners have used computerized techniques such as those of the Urban Transportation Planning System (UTPS) for years (1). For planning short-range service improvements, an efficient network-modeling capability has recently been added to UTPS. For making schedules, the RUCUS program has provided some capability, and other scheduling aids are developing. The Mini-Scheduler of the Sage Corporation of San Francisco is an example.

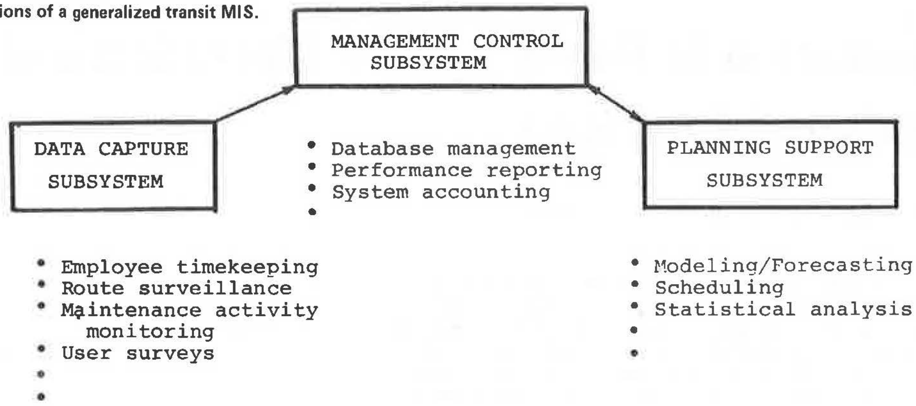
These recent accomplishments provide only a slight indication of the potential that remains for ADP methods in the following areas of transit operation and management: automated vehicle diagnostics, which includes equipment history analysis; parts inventory management for a wide variety of vehicles; computer-aided learning techniques for drivers, schedulers, and other staff; comprehensive service planning, which includes ridership estimation and cost analysis; manpower labor policy planning; financial and cash-flow management; and generally improved data collection, formatting, and reporting capabilities. All are complex and often interrelated management concerns that require integrated approaches to performance measurement and assessment.

SYSTEMS APPROACH TO OBTAINING AND MANAGING INFORMATION

After consideration of the current applications discussed above, there is obvious benefit to exploiting the significant data base that evolves naturally from use of ADP methods. If an overall systems view of agency functions and operations is taken, particularly useful flows of information can be established by design and as by-products of ADP subsystems within the agency.

Assume for the moment that a transit agency chooses to operate all feasible (cost-effective) activities by using ADP methods to improve efficiency and effectiveness. Assume as well that information for all activities could be automatically integrated and accessible to each management level that has a decision-making interest in the data. This integrated system could provide performance measurement and estimation for each responsibility center and could permit summarization of systemwide indicators. (Responsibility centers are definable activity centers that work with prescribed resources and output specific products or services. There is a manager responsible for the day-to-day operation of the center. Examples are the vehicle maintenance facility and the planning and scheduling depart-

Figure 1. Primary subsystems and functions of a generalized transit MIS.



ment.) Managers could tie goal-oriented measures of service delivery to those indicators of efficient operations. The traditional concepts of ratio analysis and the economic concepts of marginal and incremental analysis could be natural extensions of the data.

For assessing projects, the time value of money could be considered even for short-range operational commitments, especially those that may have long-range cost impacts. Thus, life-cycle cost analysis takes on meaning even for projects to be implemented in the near future. All influential aspects of agency operation could be scrutinized. Risk management methods that include the uncertain external contributions of inflation to costs and of recession on ridership could be forecast. Where appropriate, measured and forecast information could be produced as performance indicators and formatted in a way consistent with Section 15 requirements. As functionally envisioned, this overall MIS approach could provide performance evaluation capability as a management tool at the level of each individual responsibility center.

To move from a somewhat abstract discussion, an integrated MIS might appear functionally as in Figure 1. Here basic MIS functions are grouped into three fundamental subsystems: data capture, management control, and planning support. Within each of these subsystems are a number of well-defined modules, each of which takes on a specific function. For example, in the data-capture subsystem there may be individual ADP modules that feed information on ridership and revenue, vehicle maintenance, and parts availability. In the management-control subsystem there may be a module for property accounting and a module for route performance reporting. In the planning-support subsystem, modules may exist for forecasting ridership, costs, and resultant system performance. Specific indicators could be forecast for comparison with those most recently measured.

Obviously, the modules suggested by Figure 1 are only representative and could be arranged in a variety of ways depending on a specific transit agency's organizational structure and its management policies. These organizational vagaries are typical throughout the industry and further support the arguments for functional modularity. Thus a systematic framework into which various computerized modules could easily be inserted or modified provides the transit operator with maximum flexibility to change or expand the computerized management support process according to agency needs. Moreover, total process development costs over their life cycle are reduced by assuring consistency where data interfaces are required.

If we accept the systems view and the use of functions performed as modules of an overall process, we might ask pragmatically, How does one really implement a systems approach?

Though typically imagined as such, no single, large computer system need be implied. Computerized procedures that could contribute to some common denominator of essential, timely data are all that is required for overall management decision making. Visualized as a system of computerized processes, MIS modules could be developed incrementally and incorporated into the overall process according to some specified schedule. In reality, the computerized approach could be distributed to various responsibility centers with their own reporting capabilities and management tools. This approach allows for the fact that the software structure and computerized hardware essential for one module may be quite different from those for another. By being modularized, summary data for overall agency assessments may be systematically (and automatically) obtained through interfaces with the distributed data processing locations at individual responsibility centers. A computerized data-base manager is needed in cases in which many interfaces are required and much user control of the data is desired.

Further opportunities are possible when the variety of available computer and support technologies is considered. Because these numerous options exist, many decisions must be made as overall conceptualization progresses with the systems view in mind. In particular, the following types of fundamental questions must be addressed:

1. At what level of user sophistication should the processes be designed to support an overall MIS? At what level for each responsibility center?
2. What kind of ADP hardware configuration is desired or required?
3. How should staging of automated process development (integration) be accomplished?

In terms of system sophistication, transit agencies that have more-complex operating environments and greater financial and technical resources may be amenable to use of a highly flexible MIS. For many other transit agencies, a simpler turnkey type of system (i.e., one that only needs to be plugged in to be ready to work) may be preferred. However, a turnkey system does not have to be totally inflexible. Such approaches can include considerable user-oriented program organization and report-generation capability.

Depending on the desired level of automated capabilities, several hardware arrangements may apply. At some larger agencies, high-capacity multiuser computers and sophisticated support software may be desirable and cost effective for processing great quantities of data. At most other agencies, less-expensive microcomputer hardware may be suitable. In all cases, automated data entry methods will permit the movement toward more-efficient, paperless information systems. Used in conjunction with distributed processing technology, these systems offer endless possibilities for contributing to overall transit productivity.

Finally, the appropriate phasing of system implementation will vary among agencies depending on management objectives and resource availability. Usually, development of a transit MIS begins with the financial and accounting modules, since these interface with nearly all other system modules. In addition, these modules provide the means for meeting Section 15 reporting requirements. As modules are added to the MIS and experience grows, information flow becomes more comprehensive, which encourages the expansion of or interfacing with other analytical capabilities. The planning and scheduling support system is an example.

SPECIFIC RESEARCH IN SERVICE PLANNING METHODS

Because of their complex nature and high development costs, service planning methods are receiving particular attention in the Urban Mass Transportation Administration's Office of Planning Methods and Support. Projects are under way to develop what would in effect be modules of the previously proposed planning and scheduling subsystem. Many are ad hoc projects; they test the feasibility of certain analytical approaches and simplifying assumptions. Others emphasize data-collection technology.

For instance, pilot development of a stand-alone microcomputer system is being sponsored in cooperation with a particular transit agency that will provide a vehicle and driver schedule data base that will accept data typically collected from on-board surveys and counts. It will provide route-point analysis, ride checks, and on-time reliability statistics and will produce headway sheets, paddles (trip schedules), and timetables--all of which are essential to any transit operation.

Complementary to this effort, research in the near future will permit interfacing of this microcomputer system with a simply modified transit network planning capability that has comprehensive costing techniques. Vehicle and crew scheduling may be accomplished with a variety of operating objectives such as minimizing the extraboard (operator with no assigned run) or the overall vehicle-crew operating cost. With such a planning capability, another objective may be to minimize vehicle use, perhaps at the expense of driver hours. With simple analytical tools, many alternatives can be explored.

Design efforts will emphasize the concerns of the user and require minimal need for specialized ADP or computer systems knowledge. Modular considerations will permit packaging according to local requirements and allow computerized system growth as needs change and local experience and confidence evolve.

In summary, transit operating agencies must respond to local concerns and priorities and, to qualify for federal funding, must relate them to national goals as well. This implies flexibility in measuring, forecasting, directing, and reporting transit performance and productivity. Information management through automated data processing appears to offer this opportunity.

REFERENCE

1. Introduction to the Urban Transportation Planning System. Urban Mass Transportation Administration, U.S. Department of Transportation, UPM-20, March 1979.

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.

Abridgment

Evaluation of Alternative Transit Routing Configurations in a Hypothetical Low-Density Area

KEITH M. THELEN, ARUN CHATTERJEE, AND FREDERICK J. WEGMANN

The provision of fixed-route transit services in low-density suburban areas poses significant problems for urban communities. Traditionally, fixed-route bus service has been provided to these areas as an extension of the radial system in the core city. However, little information exists that would guide the selection of a certain pattern under a given set of conditions. As energy continues to be in short supply, the question of extensions of fixed-route service to low-density areas may become more pressing. This paper discusses the intrinsic service characteristics of six alternative routing patterns in a hypothetical low-density area. Costs (determined from vehicle miles traveled), coverage area, passenger travel time, and competitiveness with the walk mode are the performance measures used to evaluate each routing pattern. The results indicate that different types of routing configurations do have different implications with respect to these performance measures. No single pattern was found to satisfy all service objectives equally well. Therefore, it is necessary for decision makers to assign priorities to different service characteristics and then to make the necessary trade-offs between those characteristics to arrive at a decision that meets community objectives.

Documentation is lacking of evaluations of different transit routing configurations in low-density areas. Lundberg and Brown (1), Vuchic (2), Sullivan (3), Sharma (4), and Ross and Wilson (5) discuss issues related to different routing configurations, but none examines the specific service characteristics of alternative routing configurations. This paper discusses such specific service characteristics and the trade-offs that must be made in the route-selection process.

STRATEGY FOR ANALYSIS

Network Characteristics and Routing Patterns

Six routing patterns were simulated in a 16-mile^2 hypothetical area. The area was assumed to have uniform densities and trip-generation rates so that