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## Management Information Systems for Small, Fixed-Route, Fixed-Schedule Operators

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### ABSTRACT

Guidance is provided for managers of small, fixed-route, fixed-schedule services who are considering the purchase of a microcomputer and the necessary software for management information purposes. The major management-related functions of such services, which require the tabulation and analysis of data, are reviewed in detail and categorized into six groups: (a) administrative, (b) planning, monitoring, and evaluation, (c) operations management, (d) materials and equipment ordering and inventory, (e) maintenance, and (f) financial management. Following this review, source forms for the actual collection of the data are proposed and management reports for each function are suggested. Reference is also made to a set of criteria and standards to assist managers in the selection of the type of microcomputer and the required peripherals and software. To illustrate the use of these criteria and standards, three alternative hardware and software systems are formulated. Each system is intended to aid in all information management functions, to accom-

modate the processing of the data that have been entered from the source forms, and to generate the necessary reports. Each system consists of "off-the-shelf" software (including a data-base manager and some application programs and report generation capabilities). The hardware includes the most popular and widely used microcomputers and printers. Each system can be purchased for a total cost of approximately \$10,000 to \$12,000.

The use of microcomputers is becoming prevalent in many areas of transportation (1). The first phase of the research consisted of a broad-based and detailed review of a representative group of existing, automated, management information system (MIS) applications, the development of an evaluation framework, and the use of this framework to identify deficiencies among the existing MISs (2). MISs were studied at nine different transit sites in several different areas of the country. Sites were selected to represent widely varying fleet sizes, service area characteristics, and modes of service. In addition, a number of non-site-specific software and hardware packages were reviewed, including several within the public domain that were developed with

public funds and several that are available commercially from private companies.

The existing MISs were evaluated in terms of their capabilities, limitations, ease of use, and relative costs. As a result, it was observed that MISs are in use in transit systems of all sizes and all modes. However, most of the MISs reviewed were not comprehensive in that they served one or more MIS functions but not all of the major management information needs. Those MISs that were the most comprehensive were relatively expensive and designed for minicomputers and for use in larger transit systems. The major deficiency observed was the absence of an affordable, comprehensive MIS application for small, fixed-route transit systems (30 vehicles or fewer).

The results of continuing research to address this deficiency are presented in this paper. All major MIS functions relating to systems of this size were reviewed in detail. Original coded source forms were developed for these functions; the data elements included correspond to reporting requirements, cost-effective maintenance management, and operational, billing, and accounting needs. Criteria and standards were then developed to aid in the selection of hardware and software that could be used by small, fixed-route, fixed-schedule transit operators with varying service characteristics and data priorities. Several software and hardware alternatives that meet all standards at a total cost of approximately \$10,000 to \$12,000 were assembled.

#### MANAGEMENT FUNCTIONS

Before any hardware or software is selected, it was necessary to define and delineate all significant MIS functions for small, fixed-route, fixed-schedule services. This effort involved a synthesis of existing literature on transit management and operations (3) as well as a number of meetings with the managers of four small transit systems in Massachusetts. As a result of this effort, the MIS functions were grouped into six functional categories:

- Administrative;
- Planning, monitoring, and evaluation;
- Operations management;
- Materials and equipment management;
- Maintenance; and
- Financial management.

An explanation of each function and a list of the types of associated reports appeared in the February 1984 issue of *Bus Ride* (4). Examples of reports for each function may be found elsewhere (5). Some of these reports were submitted to federal and state transportation agencies as regular reporting requirements. Other reports have been borrowed from several non-site-specific and site-specific software packages.

#### SOURCE FORMS

The development of source forms for gathering and tabulating data for the various management functions included a review of federal and state data reporting requirements. It should be noted that the required level of UMTA and state financial and nonfinancial reporting standards (6) was used as a base to which other administrative, planning, monitoring and evaluation, operations, materials and equipment, maintenance, and internal financial data elements were added. A list of the source forms and some

projections of the potential memory storage requirements for a small, urban, fixed-route, fixed-schedule service is given in Table 1. Some forms would be completed daily; others would be used less frequently (e.g., weekly, yearly). To estimate the amount of storage capability required for each source form, the maximum number of characters on each form was determined and multiplied by the corresponding frequency of use. These estimates were then added to yield a total of more than 5 million bytes of financial and nonfinancial data produced annually. Copies of the eighteen source forms may be found elsewhere (5).

The information tabulated from the source forms is intended to provide the required reporting data as well as useful "action" data to examine the fuel consumption or maintenance requirements of a particular vehicle, overdue safety inspections, and critical shortages in parts and equipment inventory. The source forms facilitate the collection of the most significant data needed by different transit systems. Those operations that do not require or desire certain data on a particular source form would have the option of leaving that data category blank.

The source data forms used in several site-specific packages and non-site-specific packages were reviewed and compared for content with the forms discussed previously. These source forms were also reviewed critically by the transit managers of the systems in Massachusetts. Finally, the data elements for each form were precoded for computer entry. These forms may be further revised or reformulated during the testing phase to include additional data or for more efficient data processing.

#### INFORMATION FLOW AND INTEGRATION

Another important aspect to consider is how information obtained for one function such as monitoring and evaluation interrelates with information about other functions such as financial management, inventory control, or maintenance so that a report can be prepared with data from two or more source forms. An example of this type of report would be one that reports a performance statistic, such as operating cost per passenger trip. The nonfinancial information (i.e., passengers) would be obtained from source form 6 and the financial data (i.e., expenses) would be derived from source forms 15 and 16. In simpler cases, information will flow primarily within one function; for example, number of accidents for a particular vehicle for a particular period. The importance of information flow and integration will be discussed further in the section on software development that addresses data base management.

It should be stressed that building and accessing a common data base to satisfy the various management functions is critical to the development of a useful comprehensive package. This capability will help to streamline data collection and processing and reduce costly and time-consuming, multiple, manual handling of the same data within different functions.

#### HARDWARE AND SOFTWARE CRITERIA AND STANDARDS

With clear definitions of the major MIS functions, the necessary data elements, and an understanding of how the information is interrelated among the different functions, criteria were established to aid in the selection of software and hardware. Minimum requirements (standards) were also proposed for use with these criteria. These criteria, minimum re-

TABLE 1 MIS Source Forms and Memory Storage Requirements

Form #	Form Name	Use of Form	Frequency of Use	Max. Char./Form	# Char. of Memory Required
1	Employee Record Card	Personnel records	150 forms permnt.	123	18,450 permanent
2	Payroll Card	Wages & hours	150 forms/week	36	280,800 / yr.
3	Accident Report	Accidents	30 forms/yr.	63	1,890 / yr.
4	Incident Report	Complaints	75 forms/yr.	30	2,250 / yr.
5	Route/Run Set-Up	Route/run definition	100 forms permnt.	1158	78,840 permanent
6	Daily Vehicle/Route	Driver's daily log	50 forms/day	493	4,253,796 / yr.
7	Vehicle Master Rec.	Vehicle inventory	36 forms permnt.	102	3,672 permanent
8	Fluids Constants	Fuel & oil prices	1 form permnt.	43	43 permanent
9	Maint. Fluids	Record fuel metering	156 forms/week	18	144,720 / yr.
10	Maint. Service	Servicing & repair	100 forms/month	554	664,800 / yr.
11	Item Description	Parts inventory	1200 forms permnt.	188	133,824 permanent
12	Parts Issue/Request	Track & order parts	75 forms/week	19	72,000 / yr.
13	Parts Vendor Constnts	Vendor name & address	2 forms permnt.	800	1,600 permanent
14	Fares Constant	Fare types & rates	1 form permnt.	21	21 permanent
15	Purchase Request	Authorize purchases	300 forms/yr.	298	89,400 / yr.
16	Disbursement Log	Track disbursements	87 forms/yr.	235	20,445 / yr.
17	Invoice	Request reimbursements	420 forms/yr.	42	17,640 / yr.
18	Funds Receipt	Track receipts	420 forms/yr.	28	11,760 / yr.
TOTAL:					5,795,951 / yr.

**ASSUMPTIONS**

- |   |   |   |
|---|---|---|
| 1. UMass system   | 6. 75 incidents/yr.                       | 11. 1200 parts stocked                              |
| 2. 150 employees  | 7. 20 stops/run maximum                   | 12. 12 major parts vendors                          |
| 3. 30 accidents/yr.   | 8. 36 vehicles                            | 13. 15 parts/day issued                             |
| 4. 12 routes  | 9. 30 buses/day academic yr.              | 14. fare mechanism assumed<br>(available as option) |
| 5. 600 daily runs academic yr.<br>180 daily runs summer<br>60 daily runs weekends | 3 buses/day weekend<br>9 buses/day summer | 15. 435 checks issued/yr.                           |
|   | 10. 100 repair orders/month               |   |

quirements, and standards are presented in detail elsewhere (5).

**THREE ALTERNATIVE HARDWARE AND SOFTWARE SYSTEMS**

Alternative packages that are consistent with the criteria and standards were assembled. In the interests of affordability, ease of use, and replicability, newly developed "off-the-shelf" application software programs were examined. This examination produced the three candidate software packages given in Table 2 along with the range of hardware that could be used with these packages. Central to the three alternative software and hardware configurations are the respective relational, data base management programs: Logiquest, D-Base II, and Micro-Rim. Another possible alternative might be the RIM package that is in the public domain. RIM was developed by the National Aeronautics and Space Administration and is in use on minicomputer systems at the U.S. Department of Transportation Transportation Systems Center. RIM was altered for use with a microcomputer by Micro-Rim, Inc., and there were changes made to this software package that allow the program to operate with the smaller, less powerful microprocessors. The use of hard disk external data storage was also specified.

Other interesting microcomputer projects in progress were discovered during the second phase (7).

The RUCUS run-cutting package is being altered for use on a microcomputer, and a microcomputer vehicle maintenance package is being explored by the U.S. Department of Transportation Transportation Systems Center. Another run-cutting program has been written in D-Base II for the Seattle, Washington, Metro System. The Dodotrans II transportation planning programs developed at the Massachusetts Institute of Technology also operate on microcomputer hardware. The Capitol District Transit Authority in Albany, New York, uses a microcomputer with sample service data to estimate ridership and other information for system monitoring and evaluation (8).

Although much has been accomplished at the larger transit systems to aid with specific tasks and provide responsive analysis of particular models, there is a need for testing a truly comprehensive MIS for the small operator. Past and current efforts in the area of automated MIS development for paratransit by the private sector, the U.S. Department of Transportation Transportation Systems Center, the Massachusetts Executive Office of Transportation and Construction's 16-B-2 Program, and others have led to the emphasis on research on the needs of the small, fixed-route system.

**CONCLUSIONS**

As a result of this research, it has been determined that commercial software is available "off-the-

TABLE 2 Recommended Alternative Software and Hardware Packages for Phase II Testing

Software:	Alt. #1	Alt. #2	Alt. #3
- Operating System			
- Data Base Manager:	Logiquest III	D Base II	Micro-rim
- DBM Language	Pascal	D Base II	Fortran
- DBM Technical Specs	55 fields/rec, use mult. files, 15 search criteria, password protection, conditional expressions, macro processing, 8 pages/rec	65,000 char/file, multiple file usage, macro processing, 10 search criteria	127 fields/database, 20 files/database, use mult files, 254 char/field
- Resident Language	Pascal	Basic	Fortran
- Applications programs to be used	Geniledger, Accounts Pay/Rec, Inven Control, Procalle, Text Processing, Mail System	Word processor, Dutils, Quickcode	Wordstar processor (self-programmed)
- Total Software Cost	\$ 1,890	\$ 1,500	\$ 1,035
Hardware:			
- Manufacturer Alternatives	IBM personal, TRS-80 Model II, Altos	Apple II+ (w/z-80 card), Northstar Advantage, TRS-80 Model II	Apple II+ (w/z-80 card), Northstar Advantage, TRS-80 Model II
- Typical Peripheral Configuration*	5M Hard disk, letter printer (64+ K computer)	5M Hard disk, letter printer (64+ K computer)	5M Hard disk, letter printer (64+K computer)
- Approximate Hardware Cost (Typical Configuration)	\$ 9,000	\$ 9,000	\$ 9,000
Software/Hardware Approximate Total Cost (Typical Configuration)	\$10,890	\$10,500	\$10,035

\* Note: A variety of different types and qualities of printers, CRTs, and "hard" and "soft" disk peripherals are available and may be used with the various manufacturers computer alternatives in conformance with the minimum hardware standards.

shelf" that can be used with several popular micro-computer models for comprehensive information management for all major transit management functions for small and medium-sized fixed-schedule fleets. The total hardware and software cost of \$10,000 to \$12,000 appears to be reasonable with respect to typical budget levels for many transit systems with smaller fleet sizes.

The relative ease with which such an automated MIS can be implemented and the amount of staff re-training required are currently being determined during the on-going testing phase of the research. At this point, it is clear that familiarity with computer programming languages is not required of transit personnel, and it should not be necessary to hire new staff with previous computer experience to operate the automated MIS.

Unlike many existing microcomputer applications in transit, which use single-file data management software for a particular function such as inventory control or ridership analysis, the hardware and software combinations that are currently being tested have the capacity to access data from many different functional areas simultaneously so as to combine virtually any information that is collected within the transit program to produce useful management reports. The other unique feature of the package being tested is the ability to automatically

interface the information in the data base with spreadsheet analysis programs for planning, with standard bookkeeping and accounting software, with text-processing programs, and with standard inventory control software.

The implementation of comprehensive, affordable, and easy-to-use automated management information systems should serve to simplify billing and accounting procedures and aid transit officials in complying with local, state, and federal reporting requirements, such as Section 15. It is expected that an improved ability to monitor transit performance will improve the quality of both short-term and long-term decision making regarding finances, routes, maintenance, and other elements of system operations and management.

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