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

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

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

SUMMARY

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

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REFERENCES

1. H.H. Worthington, J.E. Burkhardt, S.F. Knapp, et al. Feasibility of Countywide Public Transportation for Rock County, Wisconsin, Ecosometrics, Inc., Dec. 10, 1981.
2. Crain and Associates. Definition and Travel Characteristics of the Transportation Handicapped in the CRAG Region. Columbia Region Association of Governments, Sept. 1977.

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

JOHN COLLURA, RUTH BONSIGNORE, AND PAUL McOWEN

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

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

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

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

AN OVERVIEW OF MANAGEMENT NEEDS

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

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

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

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

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

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

EVALUATION FRAMEWORK FOR MISs

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

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

Case Study Sites

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

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

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

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

Delaware Specialized Transit Authority (DAST): DAST is located in Dover, Delaware, and provides an advance-reservation, demand-responsive service for the entire state. DAST operates 48 vehicles and services 58 towns and 39 agencies with a popu-

lation of about 650,000. Because of their complex nature, the accounting, billing, and payroll functions of DAST have all been automated. The package operates on a microcomputer and includes both off the shelf and customized software programs.

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

Figure 1. Evaluation framework.

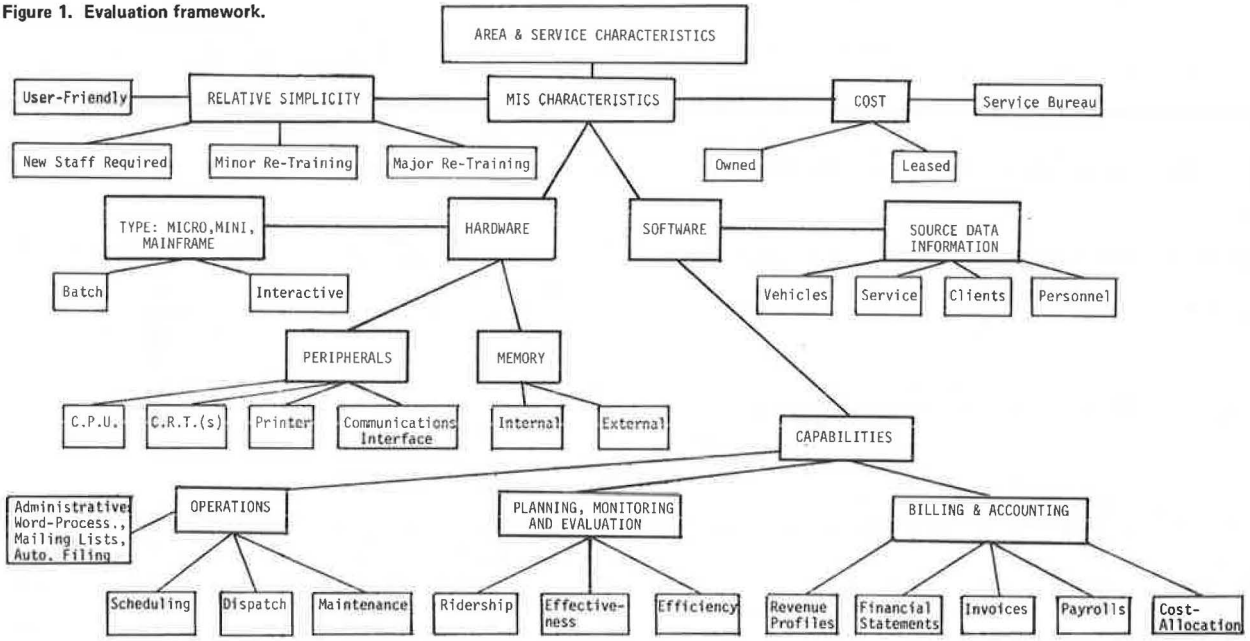

Table 1. Site and service characteristics.

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

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

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

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

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

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

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

MIS Characteristics

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

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

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

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

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

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

MIS Cost

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

Table 2. Management information system characteristics.

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

* Ozark timeshares on a mainframe computer but owns on-site equipment.

** 16 for some functions.

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

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

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

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

MIS Source Data Elements

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

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

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

MIS Capabilities

Operations and Administrative

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

Table 3. Management information system costs.

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

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

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

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

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

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

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

Many demand-responsive systems require that reservations be made 12 to 48 hours in advance in order to schedule trips efficiently. These systems may also have standing reservations for those clients who regularly ride at the same time every day or week, such as to a meal program or place of employ-

ment. These trips are entered automatically by the computer without the need for the dispatcher to reenter the trip request manually each day.

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

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

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

Planning, Monitoring, and Evaluation

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

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

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

Billing and Accounting

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

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

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

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

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

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

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

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

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

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

SUMMARY AND CONCLUSIONS

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

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

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

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

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

1. Most efforts to automate management information systems in small urban and rural areas have focused on paratransit services rather than conventional fixed-route, fixed-schedule services. These MISs generally use microcomputers or minicomputers with initial hardware and software costs of between $8,000 and $85,000 and with annual recurring costs of less than 1.5 percent of the annual operating budget.
2. A comprehensive low-cost, easy-to-use MIS has not yet been developed for fixed-route, fixed-schedule systems typically in operation in small urban and rural areas (systems with fleet sizes of 30 vehicles or less). Such a MIS should be equipped to meet the operations, administrative, billing and accounting, and planning, monitoring, and evaluation needs of transit services at an affordable cost and should be designed so that it can be used by staff with little or no computer experience.
3. There is a need to assemble and continually update a directory of computer hardware and software suitable for transit services in small urban and rural areas. Although the directory (10) prepared by the American Public Transit Association (APTA) covered many transit systems across the United States, it did not include many MISs used in small urban and rural areas. The current efforts of the NCTRP and the ITE to develop such directories should help to address this need.

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REFERENCES

1. J. Collura and D.F. Cope. Assessing User Needs in the Design of a Management Information System for Rural Public Transportation Services. TRB, Transportation Research Record 854, 1982, pp. 67-70.
2. L.J. Harman and R.V. Giangrande. Microcomputer Applications in the Management of Paratransit Operations. Presented at 2nd International Conference on Transport for Elderly and Handicapped. Cambridge University, England, July 1981.
3. B.P. Bushueff, Jr. An Analysis of the Automation Requirements for Small Coordinated Paratransit Systems. Transportation Systems Center, U.S. Department of Transportation, Cambridge, Mass., Sept. 1980.
4. Schowalter and Jobouri, CPA. OATS, Inc. Data Processing--Operators Manual. St. Louis, Mo., July 1981.
5. R.P. Schwartz. Santee Wateree RTA Management Information System. Sumter, S.C., Aug. 1981.
6. J. Collura, A.D. Rogers, and R.P. Warren. Computer-Assisted Management Information System for Regional Advance-Reservation Bus Service. TRB, Transportation Research Record 863, 1982, pp. 14-20.
7. J. Collura and M. Burkart. An Evaluation of System Performance Measures for Five Rural RTAs in Massachusetts. Univ. of Massachusetts, Amherst, Mass., 1981.
8. R.L. Scott. SIMS Implementation Handbook. MITRE Corp., Wash., D.C., Dec. 1974.
9. RUCUS II Workshop. Transportation Systems Center, U.S. Department of Transportation, Cambridge, Mass., April 1982.
10. APTA. 1980 Catalog of Management Information System Applications Within the Transit Industry. APTA Management Systems Committee and UMTA, Wash., D.C., 1980.

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