CONCLUSIONS

The procedures demonstrated in this paper present a framework for the development of a common paratransit evaluation strategy for application at the system and individual service levels. Transit operators can use the structure to evaluate their current operations as an aid in decisionmaking about service changes. The results show the feasibility and practicality of formalized indices in paratransit performance evaluation. The logical development of the performance evaluation is highly appropriate for explaining transit management options to citizen groups.

ACKNOWLEDGMENT

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Computer-Assisted Management Information System for Regional Advance-Reservation Bus Service

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A historical and technical review of the computerized management information system (MIS) implemented by the Cape Cod Regional Transit Authority (CCRTA) in 1980 is presented. The paper attempts to evaluate its success and recommends further research into options for the use of computers by paratransit providers. CCRTA's MIS meets the present operational and administrative information needs associated with the 25-vehicle b-Bus regional demand-responsive bus service, including innovative procedures for allocating costs to towns and collecting revenue from riders. The MIS generates monthly invoices for mailing to riders, who are charged according to trips taken and kilometers traveled. A similar charging scheme is used to allocate costs to member towns for service provided to their residents. The many reports generated by the MIS have proved valuable to managers, administrators, and policymakers, and the scheduling component of the MIS has resulted in faster, more efficient, and more reliable service for riders. The MIS uses a Data General Nova minicomputer, two hard-disk drives, three cathode-ray tube terminals, and a dot-matrix printer. The MIS costs about $50 000 (including hardware and software and excluding finance costs).

Demand-responsive bus service has inherently complex information needs and, as a result, a significant portion of the costs involved in providing such services can usually be identified as information management costs. Demand-responsive services frequently employ one office worker for every three or four drivers. Each individual trip involves answering a telephone; obtaining the name, address, destination, date and time desired, billing information, etc.; finding a bus that will be in the right areas at the right times; and scheduling the bus to make the pickups and drop offs. Human service agency invoices must be prepared, user fees must be collected, and statistical reports must be generated.

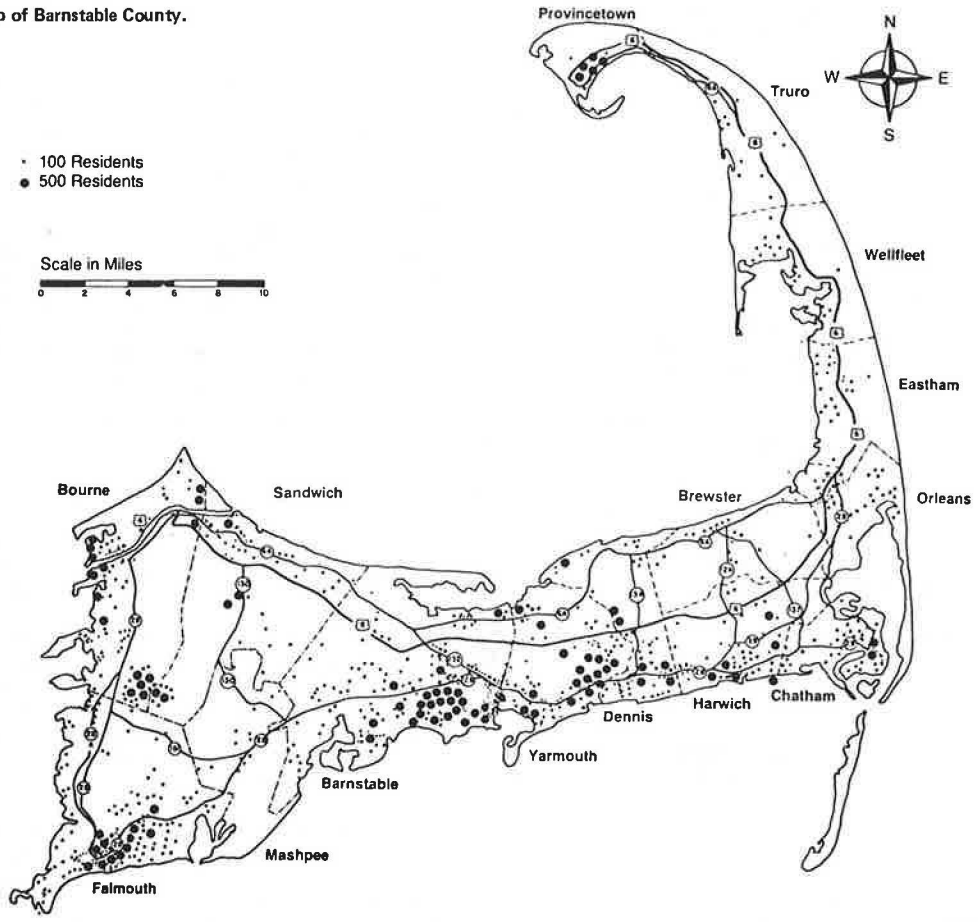
The significance of information management has been amplified by the wave of fiscal austerity now sweeping the nation. In many areas sponsors of such services are being forced to consider cutting service levels, increasing fares, and/or finding ways to reduce costs. Information management is relevant for two reasons: (a) policymakers need good information in order to make such decisions intelligently and (b) information management is one area where cost savings might be realized.

In addition, lower subsidy levels generally lead to higher costs for both users and local sponsors. Increases in user costs show the importance of equity in the generation of revenues, and increases in the local shares paid by municipalities magnify the importance of equity in the allocation of costs between municipalities.

Demand-responsive services that serve many towns have particularly complex information needs. Costs and revenues must be allocated among member towns. Each town needs to know what service they are receiving; thus, all statistics must be kept separately for each town. The variety in trip lengths is greater, so it becomes important to develop trip-length and passenger-kilometer information.

This paper describes the particular information needs of the b-Bus, a regional advance-reservation demand-responsive service provided by the Cape Cod

Figure 1. Map of Barnstable County.



Regional Transit Authority (CCRTA), and the computer-assisted management information system (MIS) that CCRTA now uses to meet these needs.

The CCRTA MIS generates more useful information than the previously used manual procedures, and it costs less. It has also facilitated implementation of highly equitable fare-collection and cost-allocation policies that would not have been practical otherwise.

BACKGROUND

Cape Cod

Barnstable County (Cape Cod), Massachusetts, has a year-round population of 140 000 and a summer population, due to an annual influx of tourists, of 450 000. The 15 communities that make up Barnstable County cover 1008 km² (389 miles²) and have a population density of 139 persons/km² (54 persons/mile²) (see Figure 1). More than one-third of the Cape's population can be described as either elderly or handicapped.

The b-Bus Program

The b-Bus is a 25-vehicle regional advance-reservation demand-responsive service. Annual ridership exceeds 150 000, and some 2500 clients are served. The FY 1982 gross costs are expected to exceed $900 000.

The b-Bus program was initially administered by Barnstable County but was turned over to the newly created CCRTA in 1979. Coordination of Cape Cod's transportation services was achieved later that year when the b-Bus was consolidated with a similar operation that catered exclusively to human service agency clients (1).

Previous Information Management Procedures

Before implementation of the MIS, the primary information processing task associated with the b-Bus program--the scheduling of 13 000 individual one-way trips each month--was a "paperwork nightmare".

More than 20 clipboards hung on a wall in the operations center, each one holding 20 or 30 drivers' schedules. When a call came in, a "Request for Service" form was completed that contained all relevant information: pass number, name, address, town, funding eligibility, if elderly, if handicapped, and the requested trip, i.e., origin, departure time, destination, requested return trip, trip purpose, etc. All information was taken over the phone from the client or from an index card file. The client was put on hold while the form was passed to the dispatcher, who then consulted the appropriate drivers' schedules on the appropriate clipboards. The dispatcher checked the appropriate box on the request form: 1, request can be scheduled; 2, alternate time suggested; or 3, request cannot be scheduled. Box 2 was the most common result. The form was then passed back to the receptionist, who reconnected with the client and informed him or her of the determination. If the trip could be scheduled, the information was later entered on the appropriate driver's schedule.

In practice this procedure was less burdensome than it might appear. Very often the receptionist would know the client and be able to fill out the

form from memory. Often the receptionist would just speak to the dispatcher to get confirmation of a request and, because many of the clients were making the same requests each week, the receptionist and dispatcher could complete the process almost immediately without use of the form and then fill out the form after the client hung up.

With consolidation had come direct responsibility for the preparation, verification, and documentation of monthly invoices required to secure human service agency funding for client transportation. The appropriate information was manually copied from drivers' schedules to large index cards and then to monthly summary sheets maintained for each funding source. The process required the time equivalent of 1.5 clerical workers and often took more than one month to complete.

Fare-collection procedures also involved considerable clerical work. All riders were given serially numbered identification cards. Possession of the pass qualified elderly and handicapped clients to free health care transportation. Other clients and elderly and handicapped persons who wanted other services paid a quarterly fee. Payment of this fee entitled a rider to unlimited service for a fixed three-month period. The pass numbers were used to track revenues and identify paid clients. When clients telephoned to schedule trips, the receptionist would check the index card file to determine if the individual was eligible for the service requested.

Another information need that was difficult to meet was the determination of trip lengths. The b-Bus covers a large area, and trip lengths vary from 128 km (80 miles) to "next door". Information about trip lengths is therefore essential to all monitoring and evaluation efforts. In addition, this information was necessary for the allocation of costs to member towns. The sharing of the vehicles by the towns made use of vehicle hours or kilometers for cost allocation impractical, and the widely varying trip lengths made allocation according to trips taken immensely inequitable to towns whose residents usually made short trips. CCRTA settled on a multivariable cost-allocation formula that takes into account trips taken and kilometers traveled by the residents of each town (2).

This information need had been met previously with off-site computer assistance. Drivers entered pickup and drop-off vehicle odometer readings on their drivers' logs, which were periodically shipped to the University of Massachusetts at Amherst. There the information was keypunched and analyzed with assistance from the University Computing Center. This process was time-consuming for drivers and administrative staff and also expensive, but the information yielded was essential to CCRTA's monitoring and evaluation program and to the implementation of the multivariable cost-allocation formula.

The information management procedures used prior to implementation of the MIS worked; i.e., the information that was clearly needed was produced. But the time equivalent of six full-time positions was consumed in scheduling, billing, fare processing, and other clerical functions. Despite this large commitment of human resources, the process was slow and inaccurate, and only essential information was generated.

Concept

It became clear to the administrative staff of CCRTA that such information management functions were ideally suited for automation. Each task could be reduced to a series of well-defined steps that are repeated many times. The manual procedures were time-consuming not because of any inherent procedural complexities but rather because of the immense volumes of information involved.

Interest in computerization of the system was present in 1976, before the service had even been initiated; however, the origin of the current MIS can be traced to an internal CCRTA memorandum written in 1978 by A.D. Rogers entitled, Proposal for a Study to Evaluate the Feasibility of Development of a Data Processing System for the Barnstable County b-Bus Program. The concept grew more popular over the months, and when staff resources were made available by completion of the consolidation project in 1979, a committee was formed to evaluate the feasibility of MIS implementation. Within months the committee unanimously agreed that computerization of the information processing functions associated with the b-Bus service would produce benefits that would outweigh the costs involved.

Implementation

The CCRTA Advisory Board later endorsed the project and in January 1980 authorized publication of a nonspecific request for proposals (RFP); non-specific meant that it did not require that computer technology be used to meet the information needs specified. In fact, one of the RFP responses constituted an offer to meet the minimum requirements (only) without computer assistance. As expected, this "man-with-calculator" response showed the largest price tag of all responses received, which included the following:

1. Two proposals to provide custom-designed microbased distributed processing systems (lowest cost).
2. A proposal to provide a sophisticated scheduling and dispatching computer system developed for large taxi operations. This system used full color video graphics to show scheduled vehicle locations and included optimizing software that would directly assist in the scheduling process (highest cost).
3. One proposal to provide a prepackaged comprehensive system designed specifically for paratransit operations.
4. One proposal to provide a custom-designed minicomputer system (median-level cost).

An RFP review committee composed of professional people from the community that had direct experience with computer applications rated the proposals and unanimously recommended an award to Crosbro, Inc., of Brockton, Massachusetts, which submitted the last proposal listed above.

Crosbro's proposal directly addressed all information needs identified in the RFP (both required and desirable), identified how needs would be met, delineated hardware component specifications, outlined software organization, and demonstrated that sufficient capacity would be available to triple the size of the operation without modification of hardware or software.

In April 1980 CCRTA awarded a contract to Crosbro for development of such a system. Over the following seven months, CCRTA staff and the operations staff worked closely with the firm in creating, adjusting, and refining the system. The MIS went on-line in December 1980 and is currently meeting all the information needs identified in the RFP.

MIS

The MIS installed at CCRTA provides on-line scheduling and provides various operational, managerial, and statistical reports. In addition, the data that

are gathered and maintained by the system enabled CCRTA to add a billing and payment system of the type necessary to support a new and innovative fare-collection system.

The MIS is operated on a Data General Nova 4/S computer with 64 kilobytes of core memory. The hardware includes 20 megabytes of disk storage, a 180 characters/s dot-matrix printer, and 3 cathode-ray tube (CRT) terminals. The hardware is expandable and can be altered to support new applications as well as greater volumes. The programs were written in Data General Business BASIC and the data files are indexed sequentially.

Scheduling and Dispatching

File maintenance and inquiry routines are available that allow operations personnel to interactively add, delete, and modify master file records; make inquiries against particular records; or produce hard copy listings of entire files.

The on-line inquiry routines are used each time a request is called in by a client. The receptionist retrieves information about a client by entering their pass number or name and then checks the appropriate schedules by entering the requested date and appropriate schedule numbers. If the trip can be scheduled, the receptionist instructs the system to transfer the trip information to the trip file. There are routines that can be used to schedule trips, one for adding trips to the trip file that were not prescheduled, and one to schedule trips that are made regularly, such as medical therapy trips. All routines require a minimum of data entry, since names, addresses, and frequently made trips are already known by the MIS.

Each evening the next day's schedules are assigned to individual drivers and vehicles and hard copies are produced. Drivers are also given log sheets on which they record vehicle odometer readings, fuel and oil consumption, maintenance data, etc. The MIS has the ability to estimate the length of any trip when given the origin and the destination; thus, it is unnecessary for drivers to record pickup and drop-off odometer readings. If any changes are made to the schedule during the day (e.g., a client does not take a trip for which he or she is scheduled), a note is made on the schedule and the change is entered into the MIS the next day along with the log sheet information.

Integration

The CCRTA MIS does not provide automated scheduling. The system does assist in the scheduling process by providing the receptionist with all necessary information and by automatically transferring relevant information to the trip file, but the receptionist still makes all the decisions.

This assistance is important; however, it also produces most of the data needed by the other MIS routines described below. If scheduling was not part of the MIS, all schedule information would still have to be entered. Integration of scheduling and administrative functions eliminates the need for batch data entry, thereby saving time and money.

Demand-responsive operations that consider implementation of single function systems should consider this integration factor carefully. It may be cost effective to obtain computer assistance for one function only (e.g., for preparation of human service agency invoices), but implementation of a comprehensive MIS would almost certainly be even more cost effective.

Maintenance

The drivers' log information described above is accumulated in a vehicle maintenance file along with information from the maintenance shop regarding tune-ups, oil changes, repair work, costs, etc. Maintenance routines produce reports that indicate the performance of each vehicle, maintenance work needed, year-to-date maintenance cost, etc.

Human Service Agency Billing

At the end of each month a routine is run that produces detailed invoice documentation for special purpose trips made by clients of human service agencies that have contracts with CCRTA for client transportation.

Client Billing

CCRTA has taken full advantage of the MIS by implementing an innovative client billing system. Previously, revenue was collected through a quarterly fee mechanism. Payment of a small fee made clients eligible for three months of unlimited service. This mechanism was inequitable in that the amounts paid bore no relation to the service used, but the fees were so low that the inequities had minimal impacts on individual clients.

In 1980 the CCRTA Advisory Board decided that revenues from the b-Bus system had to be increased significantly. Because large increases in the quarterly fees would have made the small inequities into significant problems, CCRTA developed and implemented an entirely new mechanism.

The quarterly fee mechanism has been modified and is now optional. Elderly and handicapped persons can pay a quarterly fee of $20, take medical and local trips for free, and pay $0.06/km ($0.04/mile) for nonmedical, nonlocal trips. If they choose not to pay the quarterly fee, they are charged $0.75 for each trip and an additional $0.06/km for nonmedical trips.

Other persons can pay a $30 quarterly fee and $0.10/km ($0.06/mile) for nonlocal trips. If they choose not to pay the fee, they are charged $1/trip plus $0.10 for each kilometer traveled.

All revenues are collected through an invoice mechanism similar to that used by telephone companies. When a client requests a trip, the system automatically determines if the trip is billable based on the type of client and the trip purpose. If the trip is billable (e.g., a shopping trip), the MIS calculates the distance and the fare and displays the information on the receptionist's CRT. This gives the client an opportunity to cancel prohibitively expensive trips. The date of the oldest unpaid invoice is also displayed, which gives the operator an opportunity to inquire about payment of overdue invoices.

Invoices are produced monthly and give a line-by-line breakdown of all charges incurred by the client during the past month along with all past due charges. The invoices also show nonbillable trips and discounts that may have been granted.

A cash-receipts routine allows the operator to enter payments and post them to unpaid invoices. For each entry, a payment record is created and stored in the invoice file. At the same time the payment is added to the appropriate revenue accumulator in a town file. A cash-receipts journal is printed daily that shows all payments received.

An adjustment routine allows the operator to enter credit and debit memos to adjust for over and under charging. For each such entry, a memo record is created and posted in the invoice file. The

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Analysis of Taxicab Industry in Chicago Metropolitan Area

CHRISTINE M. JOHNSON, CLAIRE McKNIGHT, ANTHONY M. PAGANO, AND LEONARD ROBINS

The Chicago Area Transportation Study initiated a comprehensive investigation of the taxicab industry in the Chicago metropolitan area in fall 1979. The study resulted in the collection of financial and trip information from a cross section of taxi companies that ranged from rural "ma-and-pa" type operations to one of the oldest and largest urban taxi fleets in the United States. Five conclusions were drawn in the analysis that have implications for public funding policy, for efforts being made to deregulate or re-regulate the taxi industry, and for the taxi industry at large. Those five findings include the following: (a) The taxi industry is chronically weakening, (b) leasing has significantly changed short-term market risk liability and incentives for productivity on the part of operators, (c) there are both economies and diseconomies of scale in taxi operations, (d) taxi service areas have become subregional as opposed to being strictly local, and (e) taxis can supply exclusive demand-responsive service for about the same per passenger cost as publicly subsidized demand-responsive services. The paper concludes with recommendations for updating taxi regulations to recognize new operating realities and a review of public funding policy as it relates to use of, or competition with, the taxicab industry.

In September 1979, the Chicago Area Transportation Study (CATS) initiated a comprehensive investigation of the taxicab industry in the Chicago six-county area, an area that includes the City of Chicago and 263 suburban and satellite municipalities. The study resulted in the collection of both financial and trip information from a cross section of taxi companies that ranged from rural "ma-and-pa" operations to one of the largest and oldest urban taxi fleets in the United States. Five of the conclusions of this two-year study have important implications for both state and federal transportation funding policies and for the taxi industry at large. The purpose of this paper is to present those five findings.

BACKGROUND

Region

The Chicago metropolitan area, which encompasses the counties of Cook, Lake, McHenry, Kane, Will, and DuPage, offers unusually fertile ground for studying the taxi industry. Within this 3719-mile^2 area are small rural communities with populations of less than 10 000 where, until the recent introduction of Regional Transportation Authority (RTA) bus service, the local owner-operator taxi was the only "public" transportation available. There are new, rapidly sprawling suburbs and other areas that are older, more densely populated, and have well-established transit and taxi systems. Finally, there is the City of Chicago, which has densities of 13 000 people/mile^2 and a central business district (CBD) served by seven rapid transit lines, seven commuter lines, and one of the oldest and largest taxi conglomerates in the United States.

Taxi Industry

Within this six-county area there are 5741 taxis, or 0.81 taxis/1000 population. Eighty percent (4600) are in the City of Chicago. Of the remaining 1141 vehicles located in the suburbs, 75 percent are located in the older suburbs of Cook County.

Most of the cab companies are old. Checker and Yellow Taxicab Companies in Chicago date back to World War I. The suburban firms, many of which grew up as feeders to commuter rail stations, have an equally long history. We found the median age to be 25 years, with several more than 50 years old.

Few of the suburban companies operate with an exclusive franchise; nearly all experience some form of competition within their service area. The suburban companies are also relatively small; the average fleet size is 21 vehicles. The range, however, is extensive; there are numerous legal and illegal owner-operators in rural areas and a few large (100 or more vehicle) associations in the rapidly growing north and northwest suburbs. By contrast, two very large and interlocking companies (Checker with 1500 vehicles and Yellow with 2500 vehicles) control 80 percent of the taxis in the City of Chicago.

Operations and organizational structure also vary within the region. Where two-thirds to three-fourths of the Chicago taxi business is street hail, 90 percent of the suburban business is dispatched and nearly one-third of that is nontraditional taxi business (either package delivery or contract work). In Chicago, more than 90 percent of the taxicabs are leased for a flat, 24-h rate, much like a rental automobile. The driver is considered an independent operator and keeps all earnings after lease and gasoline costs have been paid. One-third of the suburban taxi firms operates on a commission structure where operators and drivers split the day's gross earnings on a 60/40 basis. The remaining cab companies are either associations of owner-operators or operate under a variable-lease system. Typically, a variable lease sets the lease rate at 50-60 percent of the driver's daily gross and is thus indistinguishable from the commission structure, except that the driver is considered by the company to be an independent contractor, not an employee.

In 1970 the taxi fleet as a whole carried a significant number of the region's trips: slightly less than 1 percent; however, that modal share has slipped to less than 0.5 percent of all daily passenger trips. In fact, one of the reasons for initiating our investigation was the suspicion that the taxi industry may be seriously weakening.

SCOPE AND RATIONALE OF STUDY

CATS initiated the two-year study of the taxi industry for three reasons:

1. To assess the financial stability of the industry. There have been numerous indications at the national level that the taxi industry may be seriously weakening (1; and correspondence of the Inter-