Abridgment

AN INTERACTIVE BUS TRANSIT MANAGEMENT INFORMATION SYSTEM USING CREDIT CARD FARE COLLECTION DATA

Frank DiCesare, Rensselaer Polytechnic Institute
Gary C. Sullo, General Motor's Technical Center

This research has shown that the development of a bus transit management information system that uses data from a bus credit card fare collection system is feasible from a hardware and software standpoint. An assessment of the data available from the credit card system shows that valuable and timely ridership and revenue information, which would not be readily available otherwise, can be provided to assist in management decisions regarding changes in service, i.e., adding or abandoning service, changing service modes, changing level of service and changing fare levels and/or structure. To match the large amount of available information to the transit manager's needs, a two level form of presentation is proposed with daily indicators for monitoring transit system performance and detailed reports available on demand.

Research in transit management information systems (MIS) is particularly pertinent at this time of scarcity when transportation policy is tending towards making better and more efficient use of the transportation facilities already existing in urban areas. Public officials [1] have been stating their concern for "finding better ways to manage transit" and citing "better management information systems" as a means for improving transit management.

The research reported here addresses the feasibility of using data obtained through credit card collection as a basis for a bus transit operations MIS.

The information system is built around a fare collection system having the following characteristics:

1. Each bus has a modified fare box which accepts credit card insertion.
2. Card insertions cause a record to be entered on a cassette tape (or other storage medium).
3. Data relating to the passenger is obtained from the card, and data relating to the vehicle is obtained from the fare box according to driver entries, an internal clock and an odometer input.
4. Credit card passengers are charged as a function of distance traveled and must insert their cards upon both boarding and deboarding.
5. These cassette tapes are then removed and processed at the end of each day.

The assumptions for this scenario of usage were based in part on an UMTA demonstration project in the Valley Transit District (VTD) of Connecticut [2], where the data was used only for fare calculation and billing [3].

Previous research at Stanford University [4] examined the use of bank credit cards for fare collection and recognized the potential usefulness of the data. In the near future, UMTA plans to further demonstrate the credit card concept, including use of the data for MIS.

Transit Management Information Systems

The information systems thus far developed or discussed in the literature can be categorized by their major emphasis: maintenance, planning, or management of operations [5,6,7,8,9].

The MIS developed at the Rensselaer Polytechnic Institute (R.P.I.) during this research is aimed at transit systems offering a full range of services from fixed route to demand responsive and whose principal means of fare collection is the credit card. Further, the system developed allows for data inputs other than those generated by credit card insertions such as the dispatcher file (where dispatching is computerized) and survey data files.

Research Objectives

The objectives of this work were: to analyze the software, hardware, and data requirements; design a data base which incorporates credit card trip records; implement an example of the software; and to illustrate, by example, typical usage of the system in transit decision making.

The methodology was to assess credit card data for its management information, determine those decisions which would likely be impacted by such information and then design a system which would make the data useful to the manager in considering these decisions.

Input Data

The bus cassette records the following entries for each passenger card insertion: Record type, Passenger ID number, Fare structure code, Time,

Distance, Zone, Service type(route number or service region), and Number of persons riding on this fare account.

The dispatching file adds the following data for demand responsive services: Date, Intended time of pick-up, Bus number assigned, Service number of region, Origin zone, Destination zone, Passenger ID number, Fare structure code, Number of passengers to be served (at this pick-up), Maximum fare for this ride, Lead time (advance notice received by dispatcher), and Data code (unserved demand is recorded).

Assessment of the Data for Information Content

It is clear that this data can provide valuable statistics on ridership: volumes by zone of origin, zone of destination, origin-destination pair, time of day, week, month, etc., service mode, area or route, individual vehicle, and so on. The range of operating decisions this information can directly effect includes: adding service, abandoning service, changing service mode, increasing or decreasing level of service, and changing fare levels or structure.

A second set of statistics would be those concerning bus useage: vehicle occupancy, mileage, time, and travel speed; each by service mode and area or route. This information can be useful in the decisions cited previously as well as in the allocation, maintenance, and replacement of equipment.

System Design

The information system consists of three basic components:

1. A set of programs which read and edit the raw data and process it to create and update files for storage.
2. The online data base of files of which two, a passenger trip record file and an indicators file were implemented.
3. A set of programs which operate on the data base to generate information for the manager at two levels, aggregate performance indicators and sets of detailed statistics.

Output Information

A two level presentation hierarchy was used to avoid information overload of the transit manager. The first level is performance monitoring where the manager can compare system INDICATORS with expectations or standards in order to detect changes. The second level provides detailed systems statistics in the form of REPORTS so that a diagnosis of the problem can be made and solutions proposed.

Figure 1 gives the list of performance INDICATORS available in this system. To specify the information he wishes to see, the manager is guided interactively by the program as shown in Figure 1.

In Figure 2, a typical indicator display is shown. As a variation in this display one could also view all indicators for each period of the day, where the column headings would then read: AM peak-Base period-PM peak-Evening. This could be done for any one service type or for the system as a whole. Other variations include displaying a history of any one indicator.

The more detailed passenger movement reports produced by the information system are:

1. Origin-Destination - the number of passengers by O-D pair.
2. Ridership - a time profile of the number of passengers on board any service by hourly interval.
3. Bus Occupancy - ridership broken down further as a separate report for each vehicle, rather than by service type.
4. Passenger Boarding - ridership broken down to shown zone of boarding and deboarding within the specified service area.
5. Wait Time Distribution - distribution of time spent waiting for a late vehicle (demand responsive service).
6. Lead Time Distribution - distribution of advance notice times for demand responsive systems.

Figure 1. An example of the manager-computer interactions resulting in a particular indicator display.

```
ENTER THE SERVICE TYPE DESIRED (1-4).
ENTER 5 FOR THE CUMMULATIVE TOTAL OF ALL
SERVICES.  ANY ENTRY GREATER THAN THIS CALLS FOR
ALL SERVICES TO BE DISPLAYED INDIVIDUALLY.
USE TWO DIGITS.
---> 02

USING ONE DIGIT, ENTER THE PERIOD OF THE
DAY TO BE ISOLATED.  THE CODE IS:
     1   AM PEAK
     2   BASE PERIOD
     3   PM PEAK
     4   NIGHT PERIOD
     5   ALL DAY (SUM OF 1-4)
ANY ENTRY GREATER THAN 5 CALLS FOR ALL PERIODS
TO BE DISPLAYED CONCURRENTLY.
---> 9

ENTER TWO DIGIT CODE TO SPECIFY THE INDICATOR
TO BE PROCESSED.  ANY ENTRY GREATER THAN 15 CALLS FOR
ALL INDICATORS TO BE DISPLAYED, IF POSSIBLE.
     01 - NUMBER OF BUSSES OPERATING
     02 - BUS REVENUE HOURS
     03 - RIDERSHIP
     04 - PERCENT COIN RIDERS
     05 - UNSERVED DEMAND
     06 - VEHICLE LOADING BY MILES
     07 - VEHICLE LOADING BY HOURS
     08 - PASSENGER-HOURS STANDING
     09 - AVERAGE DEVIATION FROM DIAL-A-RIDE SCHEDULE
     10 - AVERAGE DEVIATION FROM FIXED ROUTE SCHEDULE
     11 - AVERAGE TRIP TIME
     12 - AVERAGE TRAVEL SPEED
     13 - TOTAL REVENUE
     14 - REVENUE PER VEHICLE-MILE
     15 - REVENUE PER VEHICLE-HOUR
---> 99
```

Figure 2. A typical display of all indicators for the total system by periods of the day.

ALL INDICATORS
SYSTEM AS A WHOLE
FOR ONE PERIOD OF 2 DAYS
BEGINNING DAY 10

	AM PEAK	BASE PERIOD	PM PEAK	NIGHT PERIOD	ALL DAY
BUSES IN REVENUE SERVICE	20.00	20.00	20.00	20.00	80.00
BUS REVENUE HOURS	40.00	140.00	40.00	121.98	341.98
RIDERSHIP	63.00	278.00	75.00	178.00	594.00
PERCENT COIN RIDERS	0.0	0.0	0.0	0.0	0.0
UNSERVED DEMAND	0.0	0.0	0.0	0.0	0.0
VEHICLE LOADING BY MILES	0.02	0.02	0.02	0.02	0.02
VEHICLE LOADING BY HOURS	0.55	0.76	0.63	0.46	0.61
PASSENGER HOURS STANDING	0.0	0.0	0.0	0.0	0.0
AVERAGE DEVIATION FROM PROMISED PICKUP(MIN)	-0.76	-0.34	-0.11	-0.30	-0.34
AVERAGE DEVIATION FROM SCHEDULE(MIN)	0.0	0.0	0.0	0.0	0.0
AVERAGE TRIP TIME(HRS)	0.23	0.25	0.23	0.21	0.24
AVERAGE TRAVEL SPEED	16.16	18.35	19.94	18.68	18.39
TOTAL REVENUE($)	37.98	206.64	48.24	105.84	398.70
REVENUE/VEHICLE-MILE	0.11	0.18	0.15	0.12	0.15
REVENUE/VEHICLE-HOUR	0.95	1.48	1.21	0.87	1.17

These operational reports would be called for by interactive input similar to that for displaying the daily performance indicators. In this case the questions provide the user with a menu for selecting one or several of the reports, and allow for specification of which service type to be processed. Other input would relate to time of day and dates of data to be reported.

Conclusions

The major conclusion of this research is that a useful management information system can be readily achieved in situations employing credit card fare collection.

The programming requirements are moderate and a system of this type could be implemented on a minicomputer. The flowcharts, source code, and explanatory notes available from this project [10] provide sufficient detail such that they can provide assistance in writing of functional specifications for the software in a particular implementation of this type of management information system.

A logical extension to this information system would be to adapt it to a non-credit card transit operation by the use of rider tickets issued upon entry and retrieved upon exit. Since no billing will be done with this system, ridership data can be collected on a sampled basis therefore obviating the need for a box on all buses simultaneously.

Acknowledgements

The work reported in this study was performed at the Rensselaer Polytechnic Institute and was sponsored by the University Research Program of the Urban Mass Transportation Administration under grant number DOT-UMTA-NY-11-0001. The opinions and conclusions expressed are the independent results of the authors and do not necessarily reflect the views of the sponsor or of R.P.I. and neither represents or includes any research efforts or positions taken by General Motors.

References

1. "Patricelli Views Transit Applications and Grants", Metro, Vol. 72, No. 1, Jan.-Feb. 1976.
2. RRC International, Inc., "System Operation Aspects of the Valley Transit Demonstration Program", Troy, New York, 1974.
3. Nelson, Gary, "FAIRTRAN: Operation of a Credit Card Transit Fare System", presented at the 55th Annual Meeting of the Transportation Research Board, January 1976.
4. Buckley, R.F., et. al., "Design and Analysis of an Automatic Credit Card Fare Collection System", Report No. UMTA-CA-008-74-1, NTIS No. PB-237-092, Stanford University, Stanford, CA, 1974.
5. Thurlow, V.S., SIMS Overview Service: Inventory, and Maintenance System, MITRE Corporation, McClean, VA 22101, (NTIS: PB241-495/AS), 1973.
6. Worrall, R.D., Conceptual Design for an Urban Transportation Planning Information System, Peat, Marwick, Mitchell and Co., Washington, D.C., Federal Highway Administration, Washington, D.C., (NTIS: PB-240639/5ST), 1973.
7. Dial, R.B., "Demand Forecasting for New Options and Technology-Resource Paper", Highway Research Board Special Report No. 143, pp. 77-88.
8. Fielding, G.J. and Shilling, D.R., "Dial-a-Ride: Opportunity for Managerial Control", Transportation Research Board Special Report No. 147, 1973, pp. 69-77.
9. Hartzler, R.E., "System Performance Data Processing for a Demand-Responsive Public Transportation System", Report No. UMTA- A-06-0012-74-3, MTR-6794, MITRE Corp., November 1974.
10. DiCesare, F. and Sullo, G., "A Computerized Bus Transit Management Information System Using Credit Card Fare Collection Data", Final Report to UMTA, Rensselaer Polytechnic Institute, Troy, New York, 1976, available from NTIS.