Improving Paratransit Planning in the Twin Cities Metropolitan Area

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A case study of the application of a demand-forecasting technique for demand-responsive transportation systems is presented. The paper shows how one such tool, the FORCAST model (which is based on calibration data from Rochester, New York, and Haddonfield, New Jersey), was successfully validated on two demand-responsive systems and applied in the Minneapolis-St. Paul area. The paper further shows how the demand-forecasting technique has been accepted by the Metropolitan Council (the regional metropolitan planning organization), the Metropolitan Transit Commission (the regional transit operator), and the Minnesota Department of Transportation to (a) determine the feasibility of proposed new demand-responsive services, (b) determine the expansion potential of existing community-centered transit services, (c) aid in service design changes in existing services, (d) determine whether existing services have reached their long-run equilibrium ridership, and (e) explore the possible integration between fixed-route and paratransit services in selected service areas or subregions. The paper highlights the application lessons learned from using the model and indicates on-going and future applications of paratransit models in Minnesota in paratransit and subregional planning. This experience should be of use to other communities or regions that plan to use demand-responsive transportation services.

When new paratransit systems were proposed in the Minneapolis-St. Paul (Twin Cities) area in the past, no analytical tools were available to predict the demand for, and cost of, the proposed services. Estimates of demand were based on judgment and comparison with other transit or paratransit systems in operation. Specifically, demand estimates were often based on productivities assumed or derived from fixed-route operations and neglected some unique features of paratransit operations such as doorstep pickup and drop-off, circuitous routings, and the equilibrium between supply and demand.

As a result of these ineffective planning techniques, paratransit services have often failed to meet expectations. Overprediction of demand has led to the demise of some systems, as deficits per passenger have exceeded policy maxima or when local officials viewed a system as a failure because it had not attracted the expected number of passengers. Furthermore, underprediction of demand can also have significant consequences, particularly if there are more passengers than the system can handle. Such problems, which were encountered in the Twin Cities area, were due to the lack of effective analytical tools for paratransit planning and, in particular, the inability to accurately forecast demand.

This paper presents a case study of the acquisition, validation, and acceptance of one such tool that has significantly improved the ability of planners in the Twin Cities area to design and implement paratransit options.

PARATRANSIT PLANNING AND IMPLEMENTATION IN MINNESOTA

In 1976, the Metropolitan Council of the Twin Cities Area initiated a study to consider the legal, regulatory, and institutional aspects of paratransit in the Twin Cities area. This study, which was performed with the assistance of Multisystems, Inc., led directly to the establishment of the Minnesota statewide paratransit demonstration program in 1977, which has since evolved into an on-going state transit and paratransit grant program administered by the Minnesota Department of Transportation (MnDOT).

One of the objectives of the first paratransit study initiated by the Metropolitan Council was to explore the use of general planning guidelines for paratransit services. At the end of this study, and in light of the new state paratransit demonstration program and the on-going implementation of paratransit projects by the Metropolitan Transit Commission (MTC), the Council recognized the need for paratransit planning tools that could analyze the feasibility of proposed paratransit services. Thus, in 1978 the Metropolitan Council decided to acquire state-of-the-art paratransit planning models to fill the needs of all of the major organizations charged with paratransit planning and implementation in the area. These organizations included the Metropolitan Council, MnDOT, MTC, and the local community governments.

The Metropolitan Council has three institutional roles in the paratransit planning process. Under Minnesota state law, the Council must review and approve the funding of any paratransit project that is operated either by MTC or private operators. In this role, the Council is interested in the cost-efficient and cost-effective expenditure of local, state, and federal funds. The Metropolitan Council is also responsible for producing a regional transportation policy plan that is implemented by operating agencies such as MTC. In particular, this policy plan calls for the provision of subregional transportation services in which demand-responsive and other paratransit services can play a significant role. Finally, the Metropolitan Council is responsible for producing regional travel-demand forecasts and thus maintains the zonal socioeconomic and travel data necessary to apply paratransit feasibility and service design models.

MnDOT, as administrator of the statewide transit and paratransit program, is interested in the financial and technical feasibility of proposed and on-going paratransit projects in Minnesota.

MTC has been an initiator and implementor of selective community-based demand-responsive transportation (DRT) projects in the Twin Cities area. In this role, MTC explores paratransit service design changes and the technical and financial feasibility of new services.

The local community governments are, of course, most interested in the specific design of the system and its ability to serve the needs of the residents and the business community. In many cases, this requires the ability to determine the impacts of a service on individual segments of the community. In addition, local governments are interested in the costs and revenues of the system because they affect the local subsidy required.

Five principal purposes were identified by these organizations. They included the following capabilities:

1. To determine ridership and feasibility of proposed new paratransit services,
2. To determine the growth potential for existing DRT services through determining the equilibrium (long-term) ridership potential of the service,
3. To aid in service design changes for existing paratransit services (e.g., changes in the number of vehicles used, fares, etc.),
4. To determine the expansion potential (if any) for existing paratransit services (e.g., expansion

of the service areas of the projects), and

5. To explore the possible integration between fixed-route and paratransit services in selected service areas or subregions.

It was deemed important that these models incorporate level-of-service variables such as walk times, ride times, and fares as well as geographic and demographic descriptions of the service area in order to be useful in service design and feasibility studies.

FORCAST MODEL

One of the paratransit planning tools that was acquired as a result of this process was FORCAST (1). FORCAST is a predictive package that estimates the demand for paratransit service and the quality of the service for a given user-specified service area (2). The primary purpose of the model is to predict ridership for the many-to-many dynamically dispatched paratransit services, which are commonly referred to as dial-a-ride, but it is not limited to such applications. The package has also been expanded to allow for the investigation of shared-ride taxi, exclusive-ride taxi, checkpoint many-to-many, and "cycled many-to-one" demand-responsive feeder services (3). In addition, FORCAST is capable of investigating the impact of integrating paratransit with line-haul bus or other paratransit service areas. An external transportation system, which consists of express bus, local bus, and/or commuter rail, is described in terms of the level of service provided between transfer points and zones outside of the service area.

The outputs provided by FORCAST include a description of the modal split of trips made by workers living or employed in the service area, number and modal split of trips made by the nonworking population older than 16 living in the service area, and the quality of service provided on each available mode. A report on modal ridership is produced for every period analyzed and includes a complete breakdown of trips according to market segment. Market segmentation separates out all combinations of trip purpose (work, home-originating nonwork, and non-home-originating nonwork), age category (16-64, 65 and older), and automobile ownership level (0, 1, or 2 or more automobiles per household). The level-of-service characteristics presented at each period include in-vehicle travel time, out-of-vehicle travel time, user cost, and trip distance.

Details of FORCAST

This section contains additional information on the structure and operation of FORCAST.

The FORCAST package consists of five distinct modules that predict the following:

1. Service quality of a paratransit mode based on the area served, number of vehicles used, and patronage;
2. The modal split of work trips based on the service quality characteristics of paratransit, automobile, and conventional transit modes available to the user;
3. The frequency of travel for nonwork purposes by the nonworking population;
4. Modal choice and destination of nonwork trips that originate at home; and
5. Modal choice and destination of nonwork trips that originate at nonhome locations.

These five modules are connected via an equilibration routine that iteratively searches for the point at which predicted ridership and service quality are consistent (2). This balancing of supply and demand is performed for each user-specified time period.

FORCAST contains five distinct supply models, one for each mode presented above. Each generates estimates of the average systemwide wait times and the origin-to-destination ride times experienced by patrons. The supply models for doorstep and checkpoint many-to-many dial-a-ride and shared-ride taxi are descriptive equations calibrated by using simulated service characteristics. Each of the resultant equations was able to predict, on average, the simulated wait time and ride time to within 10 percent (2). The exclusive-ride taxi supply model is similar to that of shared-ride taxi service, except that it includes a term to correct for the requirement that only one demand can be served by a taxi at a given time and recognizes that ride time is equal to that of the automobile. The taxi model was calibrated on a set of simulations performed by Gerard (4) and predicted within 3 percent all of the simulated runs reported. The supply model used to analyze many-to-one feeder services is based on work performed by Daganzo and others (5) and modified by Menhard and others (6).

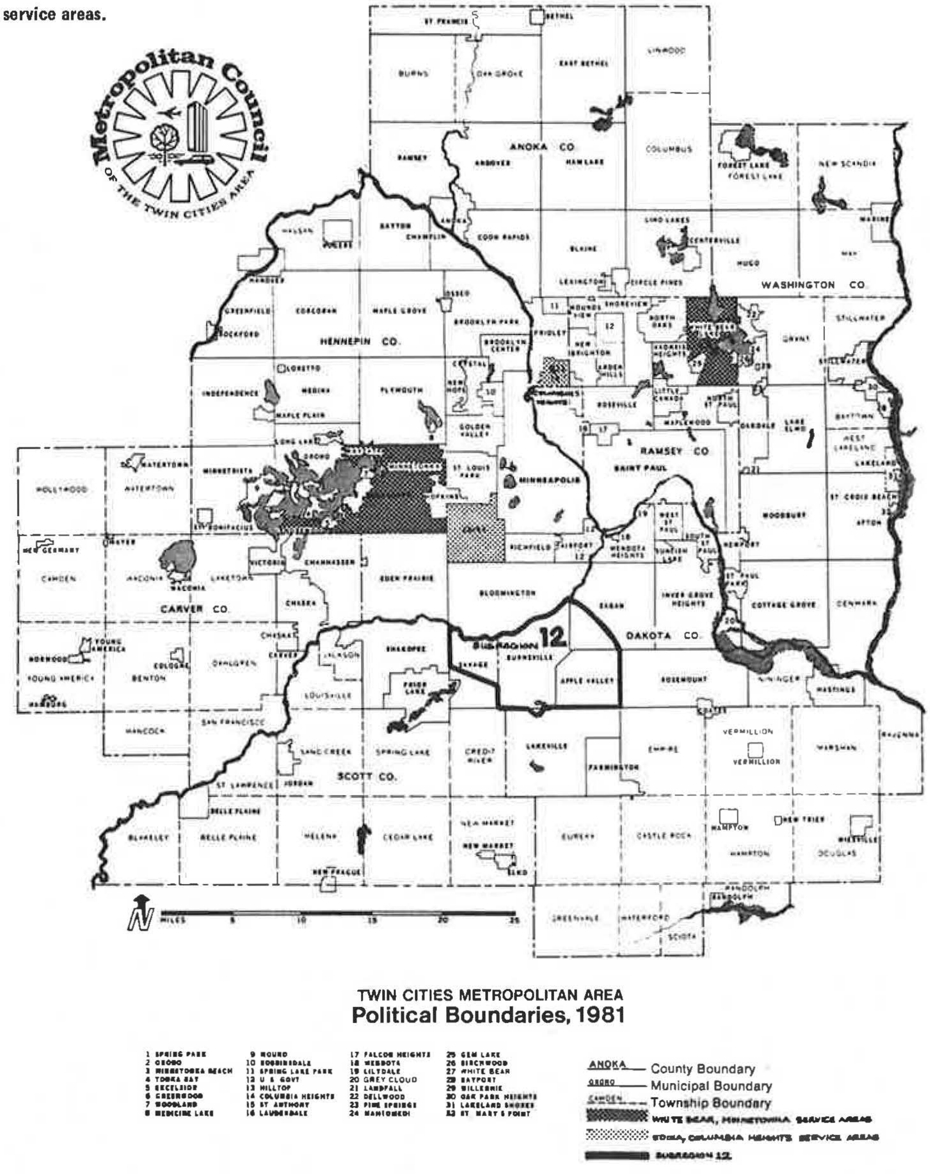
The demand estimation methodology used in FORCAST consists of four components. One is used to predict the modal split of work trips specified by an origin-destination daily work-trip matrix. The remaining three components are used to determine the characteristics of nonwork trips made in the community. Among the nonwork characteristics estimated by these portions of the model system are frequency of travel, modal split, and destination choice. All of these models were calibrated on data from Rochester, New York, and Haddonfield, New Jersey (2).

The principal methodology employed for the estimation of modal split of both work and nonwork trips and destination choice for nonwork trips is based on disaggregate choice theory (7). The disaggregate choice models employed to estimate modal split and destination in each of the demand methodology components are of the multinomial logit form (8). Travel alternatives available to one person are not necessarily those available to others. For instance, the choice of driving an automobile is not an option for an individual who cannot drive or does not have an automobile available. The set of alternatives available in the demand models includes a single paratransit mode (competing paratransit modes are not handled) plus the following conventional modes: automobile, drive alone; automobile, shared-ride; and conventional transit. The work model bases modal-split calculations on automobile ownership of the household, sex and age of the worker, and the distance, travel time, wait time, and cost of each available mode.

The nonwork forecasting methodology includes a procedure that determines the length of time a member of the nonwork population spends at his or her present location. The dwell time distributions are functions of the age of the individual, the location of the individual, whether the individual has already made a trip that day, and the automobile ownership of the household.

The nonwork choice model also estimates the probability that an individual will choose a specific mode on which to take a trip and predicts the destination zone. The set of alternatives consists of all combinations of mode and destination zone that are available to an individual. The inputs to the nonwork choice models include automobile ownership; age of the individual; the wait time, ride time, out-of-pocket travel costs, and distance of the trip by each mode available; and the area popu-

Figure 1. Paratransit service areas.



lation and employment of each potential destination.

Initial FORCAST Validations

Prior to its use by the Metropolitan Council, FORCAST was validated against paratransit and taxi services in Ann Arbor, Michigan; La Habra, California; and Davenport, Iowa. The table below presents the results of the validations:

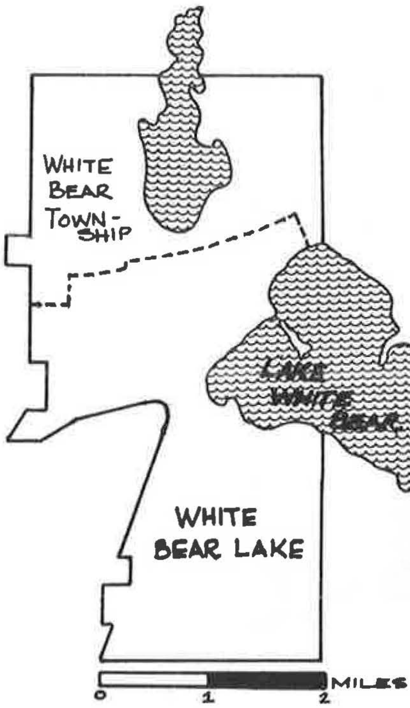
Study	Daily Ridership Predicted	Observed	Difference (%)
La Habra, 1974 (2)	266	400	-32
La Habra, 1977 (3)	280	360	-22
Davenport (2)	730	580	+29
Ann Arbor Teltrans (3)	2310	2250	+3
Ann Arbor taxi (3)	1866	1500-2000	+8

These comparisons indicate that the model should be accurate to within ±30 percent of the average daily system ridership. In addition, the breakdown of ridership into its market segments is reasonably accurate although, as expected, the confidence interval on these estimates is significantly greater than for total ridership.

WHITE BEAR LAKE VALIDATION

When FORCAST was initially acquired by the Metropolitan Council, considerable skepticism existed regarding its possible transferability to the Twin Cities planning and paratransit environment. Because the model had been calibrated on data from dial-a-ride systems that operated in Rochester, New York, and Haddonfield, New Jersey, it remained an open, empirical question as to whether the model could replicate ridership and level-of-service values experienced in the Twin Cities area. To answer this question, two local validation sites were chosen. The first validation was performed on the Community Centered Transit Service (CCTS) demonstration project, a demand-responsive system operating in White Bear Lake that used three 12-passenger vans (9). White Bear Lake is a low-density suburban residential community located to the northeast of St. Paul (see Figure 1). The population of the 19-$mile^2$ service area was 55 500 (population density of 2870/$mile^2$) when the demand-responsive system was implemented. The total employment in the service area was 3388 (employment density of 175/$mile^2$). The service was operated from 7:00 a.m. to 6:00 p.m., Monday through Friday, and had a

Figure 2. White Bear Lake service area.



general fare of $0.50. Senior citizens (65 and older), children aged 7 to 18, and handicapped persons paid half fare and children younger than 7 paid no fare. (Figure 2 illustrates the shape of the service area.)

To model this relatively straightforward dial-a-ride operation by using FORCAST, the White Bear Lake service area was divided into 12 zones. The socio-economic data inputs for each zone and for the service area as a whole were derived from 1970 census values. (Household size distributions and population age distributions have not changed substantially in this community from 1970 to 1978.) Three separate time periods of operation were considered in modeling the system; they included 7:00-9:00 a.m., 9:00 a.m.-4:00 p.m., and 4:00-6:00 p.m.

Once the FORCAST outputs were obtained for this system, the average daily ridership and breakdown of ridership by user classification were compared. (This level of examination is most relevant for decisionmakers, such as MTC, since it relates directly to revenues, costs, and subsidy levels. In addition, MTC did not collect any ridership data by time period.) Average daily ridership was obtained from average monthly ridership data collected by MTC by assuming 22 weekdays/month.

The table below presents average daily ridership comparisons between FORCAST and the actual MTC ridership:

Riders	FORCAST Model	MTC Ridership	Variation (%)
Adults (17-65)	140-144	138	+3
Senior citizens (65 and older)	30-32	21	+48
Total	170-176	159	+9

The predicted range of 170-176 average daily riders predicted by FORCAST compares favorably with an actual average daily adult ridership of 159 (an error of +9 percent). In addition, CCTS carried an average of 34 children/day who were younger than 17. Because FORCAST cannot be used to predict ridership for children younger than 16 (the model was validated entirely on adult travel behavior), these riders were left out of the comparison of actual and predicted ridership. This restriction on FORCAST's use could significantly limit its application for planning systems in which a substantial number of young people are expected to use the system. This error may in part be attributed to the exclusion of young riders from the model's calculation of service quality. Had these students been included, the quality of service (wait and ride times) for adult riders would have been reduced and fewer would be expected to use the system. Another possible source of error may be that FORCAST assumes all residents recognize their transportation alternatives whereas, in reality, some did not know about CCTS. The total predicted daily adult ridership was high by 3 percent while senior citizen ridership was high by 48 percent (although only a small number of senior citizens rode the service).

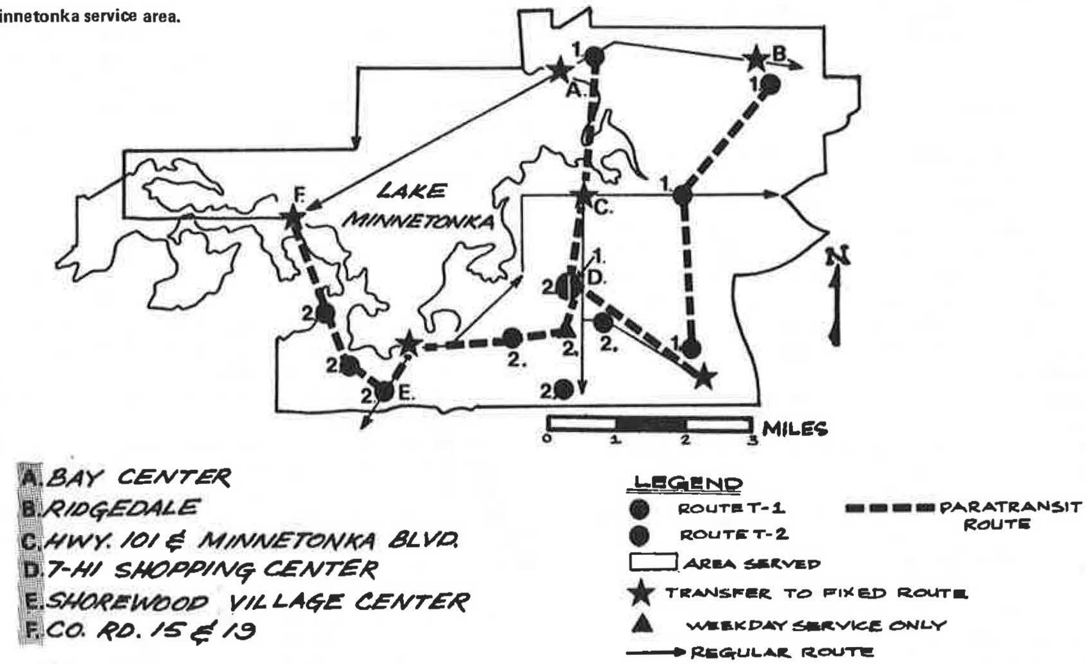
Another aspect of the validation of FORCAST was an examination of the level of service for the White Bear DRT system. (Although the ability to accurately predict level of service was not the major objective in the development of the model system, it is an implicit objective, since in the equilibrium structure of the models, errors in service predictions will produce errors in demand forecasts.) Unfortunately, MTC did not keep records of the wait and ride times experienced by the users of the system; thus, only a comparison of the actual and predicted ride distance could be made. The average trip length experienced by users of the White Bear system, as reported in MTC's evaluation of the White Bear paratransit system, was 3.0 miles. The FORCAST model predicted average trip lengths of 3.27 miles, 2.84 miles, and 3.29 miles during the 7:00-9:00 a.m., 9:00 a.m.-4:00 p.m., and 4:00-6:00 p.m. time periods, respectively. Weighted by the predicted ridership in each time period, the average daily trip length is 3.02 miles. This obviously compares very favorably with the actual average trip length.

The ability of FORCAST to replicate actual ridership and level of service to within ˙10 percent provided a positive demonstration that the model could be used in the Twin Cities area. Also, in comparison with the accuracy of methods previously used to estimate paratransit demand in the region, FORCAST performed well. Before CCTS service was implemented, patronage was projected at 134 000 passengers/year (508 passengers/day) as compared with 183/day that actually materialized. This initial estimate was high by 178 percent, whereas FORCAST results were only 9 percent higher than actual ridership. This overestimate of ridership translated directly into an underestimate of the subsidy per passenger that was used to establish the financial feasibility of the service. If the FORCAST planning tool had been available when the project was begun, the resulting subsidy of about $3.00/ride could have been predicted and a more informed decision could have been made regarding implementation of the project.

LAKE MINNETONKA VALIDATION

After the successful validation of FORCAST on the White Bear Lake service, the Metropolitan Council performed a similar validation on another local site. This site was at Lake Minnetonka in the western Hennipin County area of the metropolitan area (see Figure 1). Minnetonka is a low-density suburban residential community. The population of the 40-mile² service area was 62 140 (population

Figure 3. Minnetonka service area.



density of 1556 persons/mile^2), and total employment was 22 553 (employment density of 565/mile^2).

The Lake Minnetonka paratransit project (10), commonly known as Tonkamobile, was initiated on April 14, 1980, as a one-year demonstration project wholly funded by MnDOT through the state paratransit grant program. Two types of Tonkamobile service were offered: (a) a point-deviation paratransit system and (b) an employee subscription service. The employee subscription service accommodates commuter trips to five employment areas from the communities of Wayzata, Greenwood, Deephaven, Minnetonka, Excelsior, and Woodland. Point-deviation service, in which vehicles are scheduled to stop at a given point at a designated time, is provided during off-peak hours to communities in the Lake Minnetonka area (see Figure 3). Between points the vehicles may deviate to accommodate passenger trip requests. Several time points are coordinated with MTC regular-route service and transfers granted by the system are honored by regular-route transit and vice versa.

A patron used the off-peak service by boarding a vehicle at a designated time point or calling the radio dispatch center in advance of the trip for door-to-door service. The days, hours of operation, and fares of the point-deviation service are given below:

Item	Description
Days	Monday through Saturday
Hours	9:00 a.m.-3:00 p.m., Monday-Friday
	9:00 a.m.-6:00 p.m., Saturday
Fares ($)	
Adults	0.60
Senior citizens (65 or older)	0.30
Youth (6-17)	0.30
Children (under 6)	0
Transfer	0
Deviation	
Adults	0.20
Senior citizens and youth	0.10
Children	0

The point-deviation service used four 12-passenger vans.

Modeling this application was much more complex than that in White Bear Lake because it was necessary to replicate interactions between Tonkamobile and MTC's fixed-route operation and the designation of locations provided with essentially scheduled service. The Minnetonka service area was divided into 18 zones for the purpose of analyzing the off-peak point-deviation service. In addition, one external zone was used to represent downtown Minneapolis, which riders of the point-deviation system could reach by transferring to an MTC fixed-route bus. There was also one MTC fixed-route bus that operated within the service area in competition with the demand-responsive operation. This route was included in the analysis. No attempt was made to replicate the subscription service because it is beyond the capabilities of FORCAST.

The nonpeak period (9:00 a.m.-3:00 p.m.) was analyzed by assuming that the system operated in a many-to-many demand-responsive mode. To accommodate deviations from the designated time points, a distance circuity factor of 1.3 was used in the model. The four 12-passenger vehicles were modeled as operating with manual dispatching and an assumed vehicle speed of 18 mph. The boarding and alighting time for passengers was estimated to be 30 s. An average fare of $0.68 was used. These assumptions approximated actual operations. Socioeconomic inputs were derived from the Metropolitan Council's 1980 zone-level file. Socioeconomic inputs that were not available from the zonal files were obtained by applying the 1970 census trends to the 1980 zone base. The automobile operating cost was 6.7¢/mile in 1974 dollars.

The above analysis, which was done by using FORCAST, predicted that between 72 and 76 trips could be expected during the 9:00 a.m.-3:00 p.m. period. This gives a predicted vehicle productivity of 3.08 passengers/vehicle-h and compares with a vehicle productivity range of 2.25-2.75, which represents a daily ridership in the range of 54-66. The FORCAST patronage predictions were only 20 percent higher than actual ridership, which further supported the transferability of the model. These results led to the acceptance of FORCAST for planning applications by the Metropolitan Council, MTC, and MnDOT.

APPLICATIONS OF FORCAST MODEL

Once FORCAST was validated in Minnetonka, it was then used to analyze possible ridership increases if the service hours were extended from 6:00 a.m. to 7:00 p.m. The model was then also used to explore the effect on expected ridership of increasing fares in both the peak and off-peak periods. (The results of these sensitivity analyses are available to the interested reader from the authors and show how the model can aid in making service design changes in existing services.)

The FORCAST model is also being used for two purposes regarding existing shared-ride taxi services in the Twin Cities metropolitan area to determine the expansion potential of these shared-ride taxi services in Hopkins and Columbia Heights (i.e., Has ridership reached its equilibrium level in these municipalities?) and to explore the possible integration between fixed-route and these shared-ride taxi services via transfers. Results from these applications are not currently available.

Another application of FORCAST is for subregional planning. In 1976 the Metropolitan Council adopted a revised transportation chapter of its comprehensive Metropolitan Development Guide (11,12). The central focus of the transportation development guide and policy plan is to enhance more efficient use of existing and committed transportation investments in the region. Among other things, it suggests that future highway and transit improvements should be scaled to serve off-peak rather than peak-period demand levels, that investments in new capacity should be concentrated within the urban service area delineated by the Metropolitan Development Guide, that transit services should focus on providing for travel within subregions and to the metro centers rather than providing service between subregions, and that a wide variety of means should be considered for encouraging people to travel as passengers (whether in transit vehicles, taxis, or private automobiles) rather than as drivers.

In line with these policies, several studies are being performed to define what constitutes cost-efficient and cost-effective subregional transit services (both fixed-route and paratransit) in two separate subregions. Subregion 3 constitutes old suburbs that have high population density and fairly extensive fixed-route services. Another, subregion 12 (shown in Figure 1), is an area of much lower population density and has no public or private locally oriented transit or paratransit services. The fixed-route transit service that does exist serves primarily passengers who travel to destinations outside the subregion, especially to the Minneapolis central business district (CBD).

In subregion 3, FORCAST has been employed in its current demand-responsive mode to investigate the ridership potential and financial feasibility of community or subregionally based paratransit services that could complement the existing fixed-route transit services. In particular, demand-responsive service options were explored for the off-peak period (9:00 a.m.-3:00 p.m.) in the communities of Edina and Bloomington (see Figure 1).

In the Edina application, a nine-vehicle paratransit service was estimated to be capable of generating 550 trips daily in the off-peak period, with an average person ride time of 6.7 min and an average wait time of 31 min. This ridership was considerably higher than that experienced in White Bear Lake or Minnetonka, so a check was made to determine if these patronage results seemed reasonable in comparison with the Minnetonka results, where a successful validation was made against actual ridership figures. A run of FORCAST was made by using the same input values as those for the Minnetonka runs (i.e., with four service vehicles rather than nine). The average total DRT ridership predicted for Edina was 230 passengers in the 9:00 a.m.-3:00 p.m. period. For Minnetonka, FORCAST predicted 74 daily off-peak trips, while the actual ridership in this period was 60-65 trips.

Approximately three times the ridership would be expected to be generated in Edina as in Minnetonka. However, since the population density in Edina is 2.45 times as great as in Minnetonka and the employment density is 4.95 times as great, this result from FORCAST appears reasonable with respect to validated results.

Assuming an operating cost of service provision of $21.00/vehicle-h, fares of $1.00 for adults and $0.50 for the elderly, and an increment of youth ridership of 10 percent of total ridership (since FORCAST does not predict ridership for riders younger than 17 years of age), one can derive an operating subsidy of $1.40/trip. The ability to derive such a figure is of importance to MTC, which has a policy maximum that serves as a cutoff point for the funding of services. Thus, the ability to accurately forecast DRT ridership becomes an important input into service funding decisions.

Agency planning staffs were also interested in ridership estimates for possible evening operations (7:00-11:00 p.m.) and FORCAST was run on the Edina service area for these hours. Because none of the systems on which the model was calibrated (Rochester, New York, and Haddonfield, New Jersey) or validated has operated later than 7:00 p.m., ridership estimates for these hours could not be accepted.

The Metropolitan Council, acting for the communities in subregion 12 (primarily Eagan, Apple Valley, Burnsville, and Savage), has received a Section 6 planning grant (Urban Mass Transportation Act of 1964, as amended) to explore the feasibility of checkpoint dial-a-ride services in this area. A checkpoint dial-a-ride service would pick up passengers at selected stops (or checkpoints) in the service area rather than at their doorstep. However, the system would still be demand responsive, since persons would have to call in to request service. Some degree of doorstep paratransit responsiveness is retained, ideally enough to ensure a reasonably strong ridership; at the same time, though, some degree of doorstep paratransit's responsiveness is eliminated, ideally enough to assume the potential for high productivity.

The FORCAST model is currently being revised in order to make ridership estimates for a possible checkpoint paratransit system in this area. In its current configuration, FORCAST only predicts ridership for doorstep demand-responsive services. Accurate demand estimates will be crucial to determine the technical and financial feasibility of a checkpoint dial-a-ride system in subregion 12, since this area, in general, has a low population density.

COST OF APPLYING FORCAST

The fixed cost of data input preparation and computer setup needed to run FORCAST on a selected service area ranges from $500 to $750, depending on the size and complexity of the service area. Once this setup cost is incurred, the marginal cost of making an additional computer run to check the sensitivity of parameters is only around $10. Thus, once the initial setup is made, only a very small marginal cost is incurred to explore a variety of service design modifications.

CONCLUSIONS

The experience described in this paper shows the importance of successful validation of a demand model on conditions and systems that operate in the area where the model is to be used. This can establish the geographical and temporal transferability of the model and dissipate the initial skepticism regarding the validity of an imported model. Thus far, FORCAST has been successfully validated on a pure dial-a-ride system, a demand-responsive point-deviation service, and a shared-ride taxi operation. FORCAST ridership projections were validated to within 10 percent in White Bear Lake and 20 percent in Minnetonka. The previous method of forecasting ridership for demand-responsive paratransit systems in the Twin Cities area was based on extrapolation of fixed-route experience and exhibited errors of up to 300 percent.

After the successful validation of FORCAST, it has been accepted and made an integral part of the paratransit and subregional planning process in the Twin Cities area. It has been and is being used jointly by the Metropolitan Council, MTC, and MnDOT for a range of applications.

In summary, FORCAST is viewed as a demand-estimation technique that has been successfully transfered to the Twin Cities area and has been, and is being, used in the service design process. It is believed to provide an objective reference point for demand estimates and thus avoids any special pleading by prospective sponsors or operators of a system. It is also useful to regional and state agencies, such as the Metropolitan Council and MnDOT, that must review, approve, and fund local projects.

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