Factors Influencing Productivity and Operating Cost of Demand Responsive Transit

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Abstract

Since the enactment of the Americans with Disabilities Act in 1991 operating expenses for Demand Responsive Transit have more than doubled as demand for this mandated service has expanded. Many advanced technologies and management practices have been proposed and implemented to improve the efficiency of the service; but, evidence for the effectiveness of these actions has been based upon projections or small pilot studies. We present the results of a nationwide study involving 67 large transit agencies. We evaluate the impact of implemented technologies and practices upon productivity and operating cost.

1 Introduction

Demand Responsive Transit (DRT) systems are the means by which 'comparable transportation services' are provided to mobility impaired individuals. The Americans with Disabilities Act (ADA) mandates that all transit agencies receiving federal funds must provide such services. Since the enactment of the ADA in 1991, DRT has expanded from a national total of 42.4 million passenger trips for the year to a total of 81.8 million passenger trips in 2003. Over the same period, the annual operating expense for DRT has gone from less than 3% to more than 7% of the total for public transportation services nationally, becoming a $1.7 billion industry in 2003 (Federal Transit Administration 2003).

In the last fourteen years, many advanced technologies have been proposed to improve the performance of DRT systems. Some have achieved substantial levels of implementation. The use of Advanced Communications systems has expanded to 45% of agencies that operate in the 78 largest metropolitan areas of the country (Volpe National Transportation Systems Center 2002). Paratransit Computer Aided Dispatching (CAD) systems are used by 34% of the agencies and Automated Vehicle Location systems are used by 28% of the agencies. (Our results show much higher percentages, see Table 5, probably due to the passage of 3 additional years.) Implementations of other Advanced Public Transportation Systems (APTS) technologies are less widespread. In addition to technological implementations, a variety of management practices such as type of service, use of financial penalties/incentives for performance, and use of ridesharing have been implemented as methods to influence productivity and operating costs.

There have been studies that investigate the impact of APTS on service productivity and cost. Computers and advanced algorithms were offered to improve the dispatching and scheduling of paratransit systems (Stone, Nalevanko, and Gilbert 1994). A study sponsored by the U. S. Department of Transportation quantified expected benefits of APTS based on future forecasts (Goeddel 1996). A survey of paratransit customers in southeastern Michigan concluded that APTS has ample potential to increase customer satisfaction when reserving a trip (Wallace 1997). A study in Santa Clara County, California, reported the productivity gains realized by of use of APTS technology (Chira–Chavala and Venter 1997). The implementation of Automatic Vehicle Location (AVL) and advanced scheduling was credited as the primary factor in increasing efficiency by 10.3% for Houston's METROLift Service (Higgins, Laughlin, and Turnbell 2000).

The potential and actual impact of management practices on DRT productivity and operating costs have also been reported. There are numerous paratransit delivery methods such as single contracts, multiple contracts, or direct service (Simon 1998). A Federal Transit Administration Study found that 7.6% of total expenditures by transit operators was spent on purchased transportation (Gilbert and Cook 1999). A case study in Portland, Oregon, showed that the service cost for demand responsive transit decreased by a half when switching from direct service to contract service, primarily due to labor cost differences (Rufolo, Strathman, and Peng 1997). However, each of these studies is limited by the fact that the evidence for the effectiveness of the technologies and practices considered is based either upon projections of future performance or observations of actual performance for a small number of agencies.

Under a previous study (Dessouky, Palmer, and Abdelmaguid 2003; Palmer, Dessouky, and Abdelmaguid 2004), we conducted a nationwide benchmarking study involving an analysis of data from 62 transit agencies serving large and medium sized urban areas. Our intent was to evaluate the impact of several advanced technologies and management practices upon the productivity and operating cost of DRT systems. The advanced technologies that we considered included advanced communications, automated vehicle location, automated fare payment, automated transit information, and paratransit CAD systems. The management practices that we considered included financial incentives, financial penalties, ridesharing, agency administration, contracted administration, agency service delivery, contracted service delivery, and consumer choice.

We evaluated the impact of the implemented technologies/practices on productivity and operating cost measures derived from information available in the 1997-1999 National Transit Database (NTD). Our analysis indicated that use of a Paratransit CAD system provides a productivity benefit of approximately 12000 passenger miles per vehicle annually. Agency Service Delivery was also found to have a beneficial impact on productivity of approximately 1300 passenger trips per vehicle annually. The use of Advanced Communications technology was found to have a beneficial impact on operating cost of approximately $3.00 per passenger trip in 1998. The use of Financial Incentives was found to have a detrimental impact on productivity of approximately 7000 passenger miles per vehicle annually. The use of Financial Penalties was found to have a detrimental impact on operating cost of approximately $2.00 per passenger trip.

The results of our previous study regarding the use of Paratransit CAD systems, and Financial Penalty and Incentive clauses, raised questions about the details of their use. In the case of Paratransit CAD systems, there are many operational functions that agencies might support or replace with this technology. In the case of Financial Penalty and Incentive clauses, the conditions that trigger activation of the clauses are unknown. In this paper, we present the results of a new survey on advanced technology and management practice implementations. We received responses from 67 transit agencies that serve large and medium sized urban areas located throughout the United States. The responses provide a more detailed description of how CAD systems and financial clauses are used than has previously been available.

Among the agencies that participated in the previous study, 24 reported at least one new technology/practice implementation during the three-year period, 16 of those in 1999. As these implementations mature, their impact upon performance will become more evident. At the inception of the current study, data from the 2000-2002 NTD had become available. We combine the implementation information from our new survey with performance data from 1997-2002 to present an updated analysis of the relationships between technologies/practices and performance.

While each of the relationships identified in our previous study is statistically significant, they collectively explain only a small fraction of the observed variation in the performance measures. The list of technologies/practices that we considered in our previous work was selected through a review of the existing literature and our own knowledge of transit systems. In order to expand the list of factors under consideration, our new survey solicited the experience and expertise of transit agency personnel to identify factors not previously considered that may be explanatory of DRT system performance. Our updated performance analysis includes these newly identified factors; and consequently, we have been able to explain a substantially greater fraction of the observed variation than previously was the case.

The remainder of the paper is organized in the following way. In Section 2, we describe the survey itself and summarize the responses received. In Section 3, we present the analysis relationships between operations variables derived from the survey and the performance data from the NTD. In Section 4, we summarize our conclusions from the analysis.

2 The Implementation Survey

Data regarding the performance of DRT systems is available online from the NTD. The 2002 NTD lists 423 transit agencies that report providing a DRT service to their constituents. Of these agencies, 192 serve urban areas with a population of 200,000 or more. As in our previous study (Dessouky, Palmer, and Abdelmaguid 2003; Palmer, Dessouky, and Abdelmaguid 2004), we choose to focus on this group of 192 agencies for our survey because they provide the vast majority of DRT service.

2.1 Design of the Survey

The implementation survey had three objectives: (1) to obtain information regarding the state of implementation of advanced technologies and management practices, (2) to gather information about how CAD technology and financial clauses in service contracts are used, and (3) to gather information about other factors that might influence productivity and operating cost. We decided that closed format questions (multiple choice and fill–in the blank) would be most useful to keep the survey form short and facilitate the process of encoding responses for analysis. A copy of the survey can be found in Appendix A. Of the 192 set of agencies surveyed, we received a response from 67 agencies.

Because self–selecting respondents can produce biased survey results, we decided to segment the surveyed agencies according to industry demographic variables and focus our e–mail follow–up activities on obtaining responses from agencies belonging to under–represented segments. The demographic variables that we selected are the Population Density of the urban area serviced by an agency and the Passenger Trips per Capita. The Population Density is determined as the ratio of the population to the square miles for the agency's service area. Passenger Trips per Capita is the ratio of unlinked passenger trips for the DRT service to the population of the service area. We use data from the 2002 NTD to estimate these quantities.

Figure 1 shows the results of a cluster analysis for the surveyed agencies' demographic variables. We performed a similar analysis for our previous study (Dessouky, Palmer, and Abdelmaguid 2003; Palmer, Dessouky, and Abdelmaguid 2004). In that case, the clusters were formed using the average linkage method of agglomerative hierarchical clustering (Massart and Kaufman 1983, SAS

Institute 1988). For this analysis, we wanted to retain clusters with similar average characteristics to those identified before. Consequently, the list of surveyed agencies was divided into those who had been surveyed before and those who were newly listed. If an agency appeared on the list before, and its demographic characteristics remained similar to before, its cluster assignment was retained. The agencies with retained assignments were then used to calculate the average Population Density and Trips per Capita (the centroid coordinates) for each cluster. Newly listed agencies, and agencies with substantially changed characteristics, were assigned to the cluster whose centroid was closest. A Euclidian distance based upon values of the demographic variables that had been scaled by their respective standard deviation was used for the evaluation.

As in the previous study, there is a group of some 18 agencies that are considered outliers for the cluster analysis: 11 agencies have ridership greater than 0.99 Passenger Trips per Capita and 7 agencies serve areas with Population Density greater than 8000 persons per square mile. These 18 outliers are not represented in Figure 1, but are used throughout the rest of the current study. On the other hand, it was discovered that there is a group of 6 agencies among those surveyed that do not show reported values for the performance measures to be evaluated below, nor can they be tied via a contractual relationship to an agency that does report performance data. These 6 agencies were removed from further consideration. Table 1 shows the number of surveyed agencies in each of the demographic segments. Our goal for the survey was to achieve a 30% response rate, both overall and for each segment.

2.2 Summary of Survey Responses

In the first portion of the survey, we asked agencies to provide information about a series of operational characteristics. Most of these questions regarded policies and procedures that are

Table 1: Responses by Segment

Segment	Surveyed	Responses
Cluster 1	45	20
Cluster 2	23	8
Cluster 3	51	16
Cluster 4	18	6
Cluster 5	31	12
Outliers	18	5

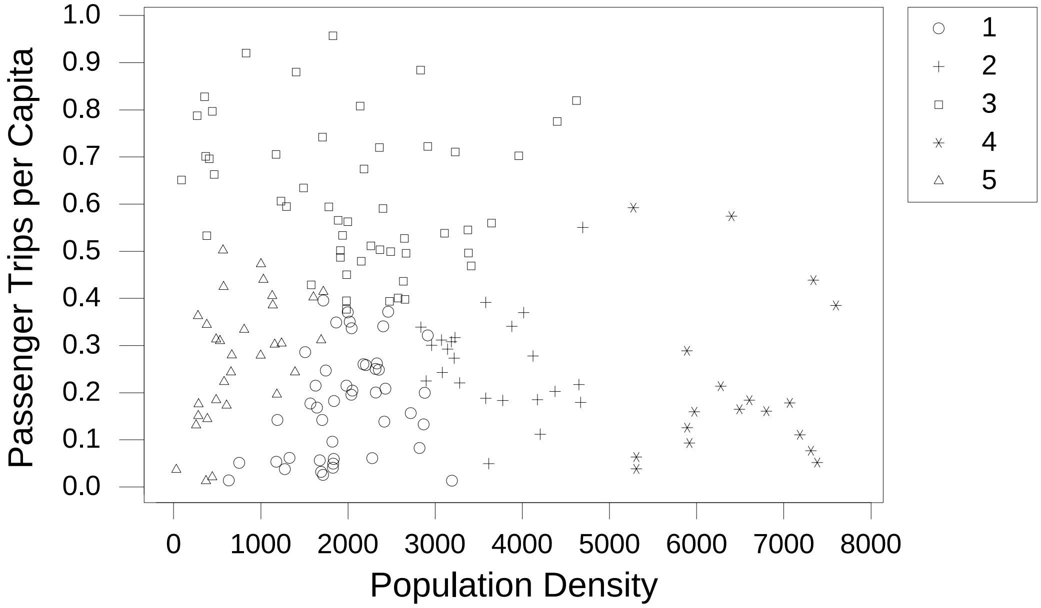

Figure 1: Clusters of Surveyed Agencies

general to the DRT service. Table 2 summarizes the responses to the yes/no and multiple choice questions in this portion of the survey. It is noteworthy that among the 49 agencies that indicate they send a letter to customers who produce no–shows, 18 agencies also indicate that there is a possibility of suspension of service for customers that produce frequent no–shows. Among the 10 agencies that indicate customers are impacted in some way other than a phone call or letter, 7 agencies employ a suspension policy and 3 agencies assess fees.

Six of the questions in the operational characteristics portion of the survey requested numerical information. Histograms of the responses to these questions are shown in Figure 2. Agencies that indicate they use zones within their service area to restrict pick–up locations for providers were asked to also indicate how many zones are used, Figure 2 (a). Among the 65 agencies that accept advanced reservations, 3 agencies did not indicate the longest notice for which a reservation would be accepted. The most common answers among the 62 agencies that did respond are 7 days and 14 days, Figure 2 (b). Among the 29 agencies that accept same–day reservations, 8 did not indicate the shortest notice for which a reservation would be accepted. The most common answer among the 21 agencies that did respond was a time less than 1 hour, Figure 2 (c). The most common

Table 2: Operational Characteristics of Responding Agencies

Yes/No Questions —	Yes	No	N/A
Is your service area divided into zones that limit where a particular provider may pick–up a customer?	12	54	1
Is scheduling coordinated across the zones?	10	2	55
Do you accept standing reservations?	58	8	1
Do you accept advanced reservations?	65	2	0
Do you handle same–day requests?	29	36	2
Do you accept requests for travel outside the boundaries of the local fixed–route bus service?	41	23	3

Multiple Choice Questions —	
On what basis are contractors paid?	
Service requests only	8
Service hours only	24
Service mileage only	4
Requests and Hours	3
Requests and Mileage	1
Hours and Mileage	5
All	1
Other	2
N/A	19
Are drivers considered employees or independent contractors?	
Employees	30
Independent Contractors	23
Both	12
N/A	2
How are customers impacted when they produce no–shows?	
No impact	4
Phone call	3
Letter	41
Phone call and Letter	8
Other	10
N/A	1

Table 3: Management Practices Implemented by Responding Agencies

	No	Yes	Before 1997	1997	1998	1999	2000	2001	2002	After 2002
				Year Implemented						
Financial Penalties	33	34	22	1	0	2	2	2	2	3
Financial Incentives	44	23	12	0	0	0	1	3	3	4
Ridesharing	27	40	38	0	0	1	0	0	0	1
Agency Administration	9	58	47	5	1	1	3	1	0	0
Contracted Administration	39	28	26	0	0	1	1	0	0	0
Consumer Choice	61	6	3	0	0	1	1	0	0	1

responses to the question regarding percentage of requests that are handled by directly operated vehicles are 'none' and 'all' (6 agencies did not respond), Figure 2 (d). For the 56 agencies that responded to the question regarding percentage of requests that are cancelled, the mean is 11% and the standard deviation is 6.8%, Figure 2 (e). Finally, for the 57 agencies that responded to the question regarding percentatge of requests that produce no–shows, the mean is 4.3% and the standard deviation is 4.3%, Figure 2 (f).

There is one question in the operational characteristics portion of the survey that asked the agency to describe how reservations for return travel are dealt with when the outbound reservation produces a no–show. Among the 54 agencies that responded to the question, 20 indicate that they cancel the return trip, 25 indicate that they keep the return trip on the schedule, 7 indicate that they contact the customer, and 2 indicate that they take some other action.

In the second portion of the survey, we asked agencies to provide information about their management practices. The initial set of questions asked about whether or not the agency uses any of six specific practices. If an agency does use one or more of the practices, we also asked them to indicate the year that each practice was first implemented. This information is summarized in Table 3. In the table, we concentrate on implementation years corresponding to the performance data that we have from the NTD. This information will be useful below, when we identify relationships between implementation and performance.

Besides the initial set of questions, we also asked a series of questions designed to delve more deeply into the use of financial penalty and incentive clauses in contracts with service providers. Two of these questions asked agencies to indicate the performance measures that are linked to penalties and incentives. Four specific measures (on–time pick–ups, productivity, customer com-

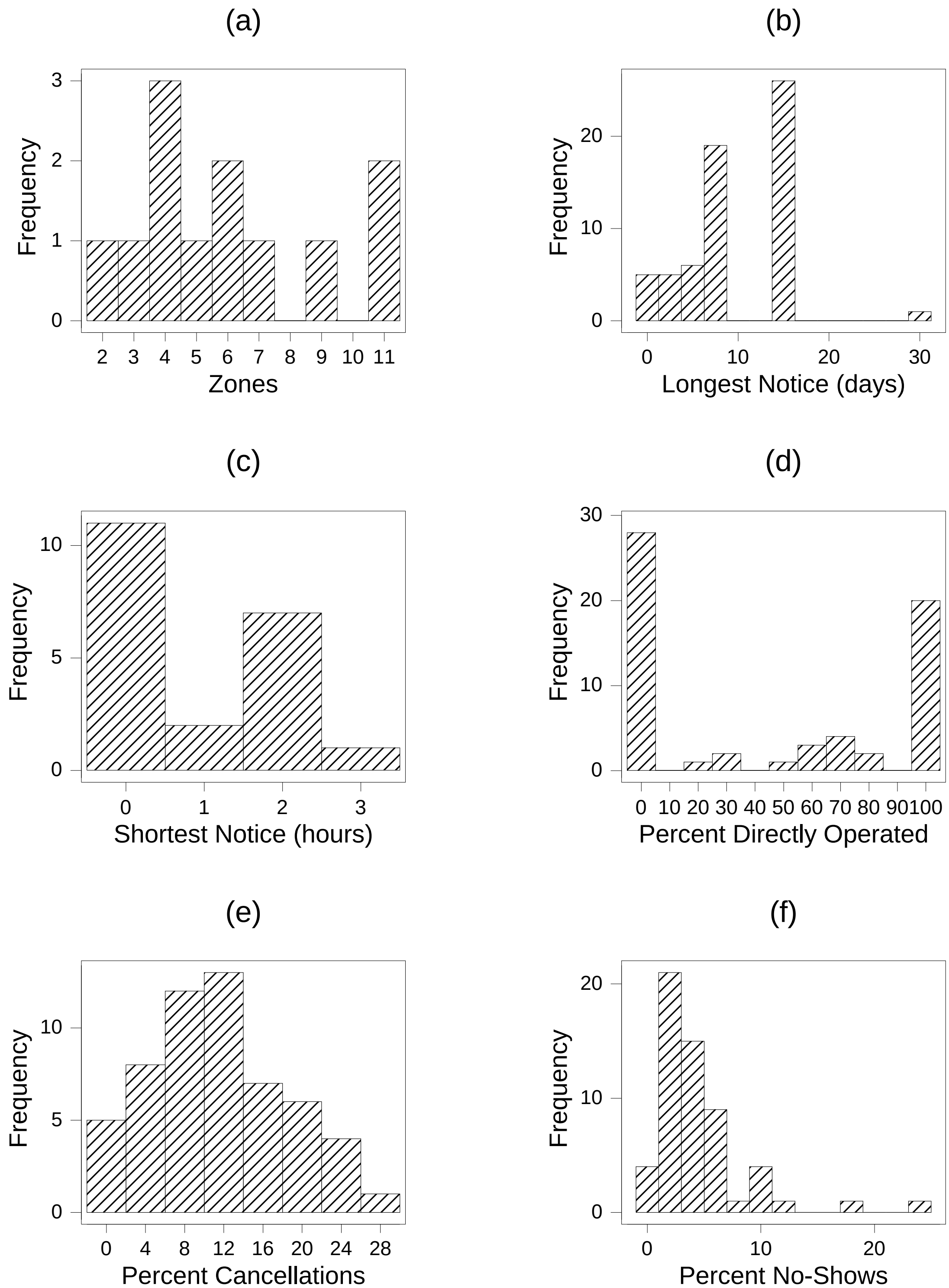

Figure 2: Operational Characteristics of Responding Agencies

plaints, and driver turnover) were offered to the agencies as multiple choice selections. The agencies were then asked to list any additional measures that they use. Their responses are summarized in Table 4. The table shows the number of agencies that use any of the four specific measures as their sole performance measure. The table also shows the number of agencies that use just one of the specific measures along with other measures not specifically offered. The most commonly listed other measures that agencies use include: no–show rates, vehicle maintenance history, accident history, and telephone response time. Lastly, the table shows the number of agencies that use combinations of the specific measures, either as the sole measures or in combination with other measures not specifically offered.

We also asked the agencies how often they assess penalties or award incentives. Among the 34 agencies that indicate they use financial penalties, 18 agencies assess the penalties monthly and 12 agencies did not respond. Among the 23 agencies that indicate use of financial incentives, 11 agencies award the incentives monthly and 8 agencies did not respond.

Our final question in the management practices portion of the survey asked agencies to give their definitions of the on–time window. Table 4 shows that 22 of 34 agencies use on–time pick–ups as one of the performance measures linked to financial penalties, and 12 of 23 agencies link on–time pick–ups to financial incentives. Figure 3 shows histograms of the responses for the limits of the on–time window. For the 59 agencies that indicate an earliest arrival time before the requested pick–up, half of the agencies use 15 minutes and most of the others use a shorter time, Figure 3 (a). For the 64 agencies that indicate a latest arrival time after the requested pick–up, half of the agencies use 15 minutes and most of the others use either 20 or 30 minutes, Figure 3 (b).

In the third and last portion of the survey, we asked agencies to provide information about their use of advanced technologies. The initial set of questions asked whether or not the agency uses any of five specific technologies. Here again, if the agency indicates usage of a technology, we also asked them to indicate the year of implementation. This information is summarized in Table 5.

We also asked a series of questions regarding details of the use of CAD systems. The agencies' responses are summarized in Table 6. With regard to the period of time over which a route is planned, beyond the given options of full–day or half–day, agencies plan for full shifts or build routes in real–time. With regard to the number of requests given to a driver, agencies not using

Table 4: Performance Measures Linked to Financial Clauses

	Penalties		Incentives	
	w/o Other	with Other	w/o Other	with Other
1) On–time pick–ups	4	2	1	2
2) Productivity	3	0	3	0
3) Customer complaints	1	1	1	2
4) Driver turnover	1	0	0	0
(1) and (2)	3	1	1	2
(1) and (3)	5	2	0	1
(1) and (4)	1	0	0	0
(1), (2), and (3)	1	2	1	3
(1), (2), and (4)	0	1	0	1
Other only	2		2	
N/A	4		3	

Table 5: Advanced Technologies Implemented by Responding Agencies

			Before	Year Implemented					After
	No	Yes	1997	1997	1998	1999	2000	2001	2002	2002
Advanced Communications	21	46	28	3	1	3	2	7	0	2
Automated Vehicle Location	37	30	5	0	0	3	3	10	1	8
Automated Fare Payment	61	6	0	0	0	0	1	3	0	2
Automated Transit Information	59	8	0	0	1	0	0	2	0	5
Paratransit CAD System	13	54	25	2	3	4	6	9	0	5

full–day or half–day will give a 1-2 hours or less. The amount of requests communicated is sometimes limited by the display capability of a mobile data terminal.

Last of all, we asked "How long in advance are routes planned?". Figure 4 shows a histogram of the responses. Among the 45 agencies that responded, more than half plan 1 day in advance.

3 Relationships between Operations and Performance

The survey responses from each agency provide a description of the operations of their DRT service. The National Transit Database (NTD) provides data that can be used to describe the performance of each agency's DRT service. We use regression models to identify relationships between the operations and the performance. The first step of the analysis is selection of the performance measures.

Table 6: Use of Paratransit CAD systems

How are service requests grouped into routes for each vehicle?	
Manually	11
Automatically, using CAD	39
Both	15
N/A	2
If routes are created automatically, does dispatch staff revise the routes manually before use?	
Yes	49
No	5
How are routes revised during the time of use?	
Manually	42
Automatically, using CAD	9
Both	10
Other	1
N/A	5
Over what period of time is a route planned to occur?	
Full-day	47
Half–day	5
Both	7
Other	4
N/A	4
What is the amount of requests given to a driver at one time?	
Full-day	49
Half–day	2
One–at–a–time	0
Other	14
N/A	2

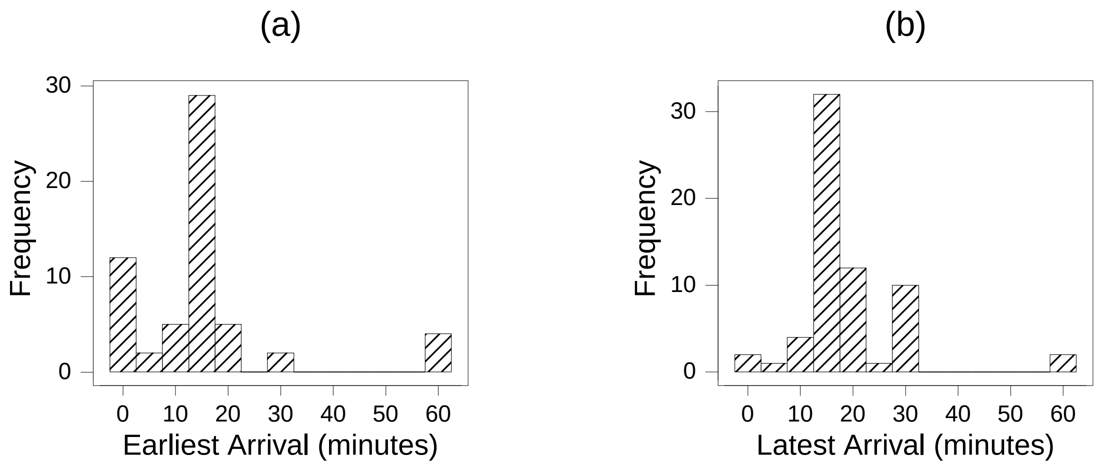

Figure 3: Limits of the On–Time Window

3.1 The Performance Data

In our previous work (Dessouky, Palmer, and Abdelmaguid 2003; Palmer, Dessouky, and Abdelmaguid 2004), we used the following performance measures

- Passenger Miles per Vehicle, $PassMil/Veh$
- Passenger Trips per Vehicle, $Trip/Veh$
- Operating Expense per Passenger Trip, $OpExp/Trip$
- Operating Expense per Passenger Mile, $OpExp/PassMil$

These performance measures are constructed from data available for each agency in the annual NTD. Passenger miles are the total of distances traveled by each passenger. Passenger trips are the total of unlinked trips made by each passenger. The number of vehicles is the number reported as the maximum actually operated to provide service on an average weekday. Operating expense is the total of contracts for purchased transportation and expenses for directly operated DRT services.

The performance measures above were selected to represent the characterisitcs of productivity and operating cost. Productivity is defined as output per unit input. Both output and input can

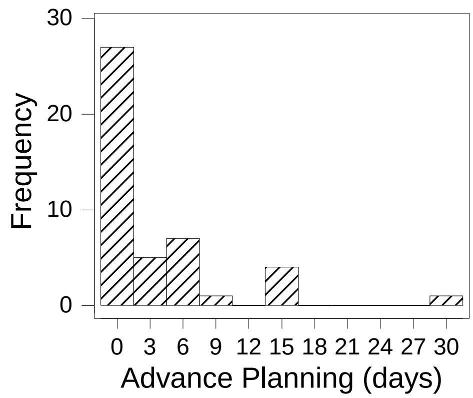

Figure 4: Time in Advance that Routes are Planned

be measured either in monetary or non–monetary terms. Traditional measures of productivity, such as economic value of services provided per labor hour, are inconvenient to use in this case because the economic value of DRT services is neither commonly reported nor easily estimated. The National Transit Summaries and Trends (NTST) report (Federal Transit Administration 2003) uses revenue hours as a non–monetary measure of output. The NTST report also offers passenger miles and passenger trips as examples of non–monetary measures of consumption. The distinction between consumption and output is a recognition that some output is not used by the customers.

For our measures of productivity, we prefer to focus on the utilized portion of output, measured by passenger miles and passenger trips. Since we are examining operating cost as a separate perfomance characteristic, we choose to use number of vehicles as a non–monetary measure of input. For our measures of operating cost, it is appropriate to use cost per unit output so that services of varying scale may be compared. It should also be noted that, in our analysis, operating expenses have been inflation adjusted to constant 1999 dollars.

Ideally, each measure should represent an independent performance characteristic. To investigate this issue for the measures described above, a principal components analysis (Johnson and Wichern 1992) was performed separately for each year of NTD data (1997 through 2002). Data for all agencies in the survey group was used. The six analyses produced consistent results. The results reveal that these measures are most naturally arranged into two groupings. The first group, consisting of $PassMil/Veh$ and $Trip/Veh$, represents one characteristic that we interpret to be productivity. The second group, consisting of $OpExp/PassMil$ and $OpExp/Trip$, represents another characteristic that we interpret to be operating cost. However, these two characterisitcs are not independent. They have a weak negative correlation with each other. Agencies that have high productivity also tend to have low operating cost, and visa versa.

The two measures within each grouping are positively correlated. The strongest positive correlation is that between $OpExp/PassMil$ and $OpExp/Trip$. Since we could devise no individual interpretation for these measures, nor a reason to prefer one over the other, we chose to define an Average Operating Cost (AOC) measure, see Equation 1 for an example based on the 2002 data. The AOC is formulated as the mean of the scaled performance measures. The values \$20.630 and \$10.073 are the mean and standard deviation of $OpExp/Trip$ for the 186 agencies surveyed. The values \$2.6126/mile and \$1.1854/mile are the mean and standard deviation of $OpExp/PassMil$.

$$AOC \equiv \left(\frac{OpExp/Trip - 20.630}{10.073} + \frac{OpExp/PassMil - 2.6126}{1.1854} \right) \div 2 \tag{1}$$

We interpret $PassMil/Veh$ as being related to the portion of miles traveled by the vehicle that is productive. We refer to this characteristic as mileage productivity. We interpret $Trip/Veh$ as being related to the number of passengers travelling simultaneously in the vehicle. We refer to this characteristic as people loading productivity. While the interpretation of these measures is inspired by the concepts of mileage productivity and people loading productivity, we must admit that neither measure can be said to represent solely one or the other characteristic. For example, $PassMil/Veh$ can be increased by shortening trip segments when the vehicle carries no passengers, thereby allowing the vehicle to service more requests over the same number of total miles. But, $PassMil/Veh$ can also be increased by carrying more than one passenger at a time, thereby multiple counting the miles when the vehicle is carrying passengers. Similarly, one could argue that both effects can influence the $Trip/Veh$ measure.

Having selected the performance measures, the next step is to define the operatons variables that are derived from the survey responses.

3.2 Operations Variables

A total of 28 operations variables have been defined to represent the responses given in the survey. Most of the operations variables, 24 in all, are defined as indicator variables. For each of these, the value 1 indicates that the characteristic in question is used and the value 0 indicates that the characteristic is not in use. The four remaining operations variables are defined as continuous values. Two of these are times expressed in days or minutes, respectively. The final two variables are percentages, actually proportions expressed as a value between 0 and 1. Tables 7, 8, and 9 show the list of operations variables.

Two of the indicator variables, Directly Operated and Purchased Transport., are used to encode the answers to the survey question regarding the percentage of service requests handled by directly operated vehicles. As Figure 2 (d) shows, 19 of the agencies have 100% directly operated (Directly Operated = 1, Purchased Transport. = 0), 28 agencies have 0% directly operated (Directly Operated = 0, Purchased Transport. = 1), and only 15 agencies have an intermediate result (5 agencies did not provide an answer). Given these results, the use of a continuous variable is unnecessary. Two indicators are used so that agencies having percentages between 0 and 100 may be represented appropriately. These indicators can also be verified by comparison to the NTD.

A concern regarding the creation of operations variables was that each of the indicators should offer a good split between the two outcomes. If an overwhelming majority of the responding agencies failed to display a particular characteristic, it would not be possible to evaluate the performance impact of the characteristic because there would be too little evidence of the performance in the presence of the characteristic. A similar problem would occur if an overwhelming majority of agencies displayed the characteristic. There would be too little evidence of the performance in the absence of the characterstic. Each of the indicators shown in Tables 7 and 8 has at least 8 agencies represented in each outcome.

Some characteristics that were investigated in the survey did not produce enough agencies that displayed the characteristic to warrant an operational variable for the characteristic. The Consumer Choice management practice had only 5 responding agencies who had implemented the practice during the 1997-2002 performance window, see Table 3. The Automated Fare Payment technology was only implemented by 4 agencies and the Automated Transit Information technology

Table 7: Operations Variables, Part 1

Variable	Question/Measure
Indicator Variables	
Zones	Is your service area divided into zones that limit where a particular provider may pick–up a customer?
Standing Reservation	Do you accept standing reservations?
Same Day	Do you handle same–day requests?
Outside	Do you accept requests for travel outside the boundaries of the local fixed–route bus service?
Directly Operated	What percentage of service requests does your agency handle by directly operated vehicle?
Purchased Transport.	What percentage of service requests does your agency handle by directly operated vehicle?
Service Requests	On what basis are contracted providers paid? – service requests
Service Hours	On what basis are contracted providers paid? – service hours
Service Mileage	On what basis are contracted providers paid? – service mileage
Financial Incentives	Payments to contractors, in addition to the base fee, that are contingent upon service performance results
Ridesharing	A vehicle simultaneously serves trip requests from more than one customer by use of a carpooling strategy
Agency Admin.	The agency named on the survey performs the following functions: determines ADA eligibility, arranges for use of vehicles and services of drivers, monitors service performance, and distributes funds in payment for transportation
Contracted Admin.	The agency named on the survey contracts another organization(s), most likely a private operator, to perform the functions listed above

Table 8: Operations Variables, Part 2

Variable	Question/Measure
Indicator Variables (cont.)	
On–time	What performance measures does your agency link to financial penalties? – on–time pick–ups
Productivity	What performance measures does your agency link to financial penalties? – productivity
Complaints	What performance measures does your agency link to financial penalties? – customer complaints
Other	What performance measures does your agency link to financial penalties? – other
Adv. Communications	A digital radio or wireless personal communication system used to transmit voice and/or data between the vehicle and the dispatch center
Auto. Vehicle Location	A computer–based tracking system that includes a method of determining vehicle location (such as global positioning system, active signposts, ground–based radio) and a method of transmitting data from the vehicle to the dispatch center
Auto. Grouped	How are service requests grouped into routes for each vehicle? – automatically, by using a CAD software
Manual Grouped	How are service requests grouped into routes for each vehicle? – manually
Auto. Revised	How are routes revised during the time of use? – automatically, by using a CAD software
Manual Revised	How are routes revised during the time of use? – manually
Planning Period	Over what period of time is a route planned to occur? – full–day

Table 9: Operations Variables, Part 3

Variable	Question/Measure
Continuous Variables	
Longest Notice	Longest number of days advanced notice that a customer may request a pick–up
%Cancelled	Percentage of service requests that customers cancel after routes are planned
%No–shows	Percentage of service requests that customers fail to show for the pick–up
Latest Arrival	Latest arrival time after requested pick–up that is considered on–time, in minutes

was only implemented by 3 agencies, see Table 5.

A second concern about the operations variables was that they should be nearly independent of each other. If a large portion of the responding agencies display two characteristics concurrently, then it is not possible to separate the impacts of the two on performance via the regression techniques that we use. A correlation analysis (Draper and Smith 1981) of the operations variables was performed to identify any characteristics that tend to be concurrently displayed.

The correlation analysis revealed that Financial Incentives are concurrent with the On–time, Complaints, and Other indicators. These indicators represent performance measures that are linked to financial penalties. All agencies that implement financial incentives also implement financial penalties. As a result, it is not possible for us to determine the impact of using financial incentives in the absence of financial penalties. The On–time indicator is also correlated with the Productivity and Complaints indicators. See Table 4 for a detailed description of the concurrent usage of these measures.

There is a relationship between the use of Automated Vehicle Location technology and the practice of Manually Grouping service requests into routes. Agencies that have AVL technology do not use manual grouping. As a result, it is not possible for us to determine the impact of using manual grouping in the presence of AVL technology.

A final issue connected to operations variables is the timing of management practice and technology implementations. If a practice/technology was implemented during the time frame of our performance evaluation, the performance measures reported during the transition could not be considered to be representative of typical pre– or post–implementation performance. Consequently, if a practice/technology was implemented within the 1997-2002 time frame, the performance measures for the year of implementation were removed from the analysis. Tables 3 and 5 show the amount of data loss for this cause.

3.3 Analysis Results

We began by analyzing relationships to the $PassMil/Veh$ productivity measure. Linear regression techniques were used to evaluate the statistical significance of the relationships between $PassMil/Veh$ and the operations variables. The first step was to scale the measure using its mean and standard deviation, see Equation 2 for the 2002 data example. A Box–Cox power transformation (Draper and Smith 1981, Myers and Montgomery 1995) was applied to the scaled measure to improve the normality of the regression residuals. Separate maximum likelihood estimates of the power transformation exponent were calculated for each year of NTD data. The estimates were found to be consistent; so, a single value for the exponent ($\lambda = 0.75$) was selected for uniform application across all years of NTD data. Finally, a stepwise regression procedure was used to select the terms in the model for each year. Tables 10 and 11 show the results of the regression analysis. The tables show all model terms found significant at the 4% level. Since the purpose of these models is to identify statistically significant relationships between $PassMil/Veh$ and the operations variables, the intercept estimates are omitted from the tables.

$$ScaledMiles = \frac{PassMil/Veh - 38455}{18834} \tag{2}$$

The most consistent relationship to $PassMil/Veh$ is with the use of Paratransit CAD technology to automatically group trip requests into routes. This relationship is observed in all years except 2001. The sense of the relationship is positive. Agencies that Auto. Grouped have a greater $PassMil/Veh$ value than agencies that do not. For the 1997 data, responding agencies that Auto. Grouped had a mean $PassMil/Veh$ value of 37200 miles/vehicle, while the responding agencies that had not Auto. Grouped technology had a mean value of 27700 miles/vehicle. For 1998, the mean values are 37500 miles/vehicle for Auto. Grouped versus 27600 miles/vehicle for not Auto.

Table 10: Passenger Miles per Vehicle Regression Results

y: $(ScaledMiles + 3)^{0.75}$

	1997		1998		1999	
Term	Coeff. Est.	p–value	Coeff. Est.	p–value	Coeff. Est.	p–value
Auto. Grouped	0.35	0.035	0.35	0.033	0.62	0.000
%No–shows	—	—	—	—	5.37	0.013
Complaints	—	—	0.60	0.001	—	—
Productivity	—	—	0.37	0.022	—	—
Other	—	—	0.33	0.017	0.35	0.006
%Cancelled	2.11	0.019	—	—	—	—
Zones	−0.33	0.033	—	—	—	—
R–sq(adj)	28%		37%		40%	

Table 11: Passenger Miles per Vehicle Regression Results

y: $(ScaledMiles + 3)^{0.75}$

	2000		2001		2002	
Term	Coeff. Est.	p–value	Coeff. Est.	p–value	Coeff. Est.	p–value
Auto. Grouped	0.83	0.004	—	—	0.45	0.009
Manual Revised	—	—	−1.11	0.000	—	—
%No–shows	16.50	0.000	7.28	0.004	4.85	0.001
Productivity	—	—	0.59	0.002	—	—
Other	—	—	—	—	0.41	0.004
Service Mileage	—	—	−0.40	0.025	—	—
R–sq(adj)	39%		66%		36%	

Grouped. For 1999, the mean values are 40200 miles/vehicle for Auto. Grouped versus 24500 miles/vehicle for not Auto. Grouped. For 2000, the mean values are 38900 miles/vehicle for Auto. Grouped versus 23500 miles/vehicle for not Auto. Grouped. Finally, for 2002, the mean values are 38100 miles/vehicle for Auto. Grouped versus 31100 miles/vehicle for not Auto. Grouped. The results for 1998 and 1999 are consistent with our previous study. We found no significant terms in the previous study's 1997 data. These results confirm that the use of CAD systems for route creation is beneficial.

The second most consistent relationship to $PassMil/Veh$ is that of %No–shows. This relationship appears in 1999-2002. The sense of the relationship is positive. Agencies with relatively high no–show rates have a greater $PassMil/Veh$ value than agencies with relatively low no–show rates. For the 1999 data, the difference between an agency with 2% no–shows and an agency with 6% no–shows is 6700 miles/vehicle. For 2000, the difference between 2% no–shows and 6% no-shows is 18800 miles/vehicle. For 2001, the difference is 10400 miles/vehicle; and, for 2002, the difference is 5800 miles/vehicle. We interpret the seemingly beneficial impact of no–shows on this performance measure to be a result of the additional mileage that a would–be ridesharing passenger travels when the vehicle attempts to service a no–show request. It is an imperfection in the formulation of the productivity measure that produces this regression result. Agencies should not attempt to increase their no–show rates.

In 1998, 1999, 2001, and 2002 relationships to Complaints, Productivity, and Other are observed. These variables all indicate the use of financial penalty clauses in contracts with service providers. In each case, the sense of the relationship is positive. Agencies that use the penalty clauses have a higher $PassMil/Veh$ value than those that do not. For the 1998 data, agencies that used penalties linked to Complaints had a mean $PassMil/Veh$ value of 47000 miles/vehicle, while agencies that did not use penalties linked to complaints had a mean of 34000 miles/vehicle. In the same year, agencies that used penalties linked to Productivity had a mean of 47400 miles/vehicle versus 33900 for those who did not. Also, agencies that used penalties linked to Other measures had a mean of 44100 miles/vehicle versus 34000 miles/vehicle for those who did not. For 1999 and penalties linked to Other, the means are 43500 miles/vehicle versus 32500 miles/vehicle. For 2001 and penalties linked to Productivity, the means are 50300 miles/vehicle versus 32800 miles/vehicle. Finally, for 2002 and penalties linked to Other, the means are 43900 miles/vehicle versus 33700 miles/vehicle.

The results for 1998 and 1999 that indicate a beneficial impact from the use of financial penalty clauses in contracts with service providers are in conflict with the results of our previous study. The previous study showed no significant impact of financial penalties in 1998, and showed the combination of financial penalties and incentives to be detrimental to productivity in 1999. We can offer no interpretation for this seemingly beneficial impact of financial penalties. We do note that there are only 19 agencies in common between the responders to our previous survey and this current survey. There may be an as yet uninvestigated variable that accounts for the superior productivity of the agencies in the current survey group who use financial penalties. We also note that when the 1999 data for the two survey groups are combined, the financial penalties variable becomes insignificant. This observation further supports the hypothesis of stratification between the two survey groups according to an unidentified variable.

For the 1997 data, there are two relationships that have not yet been discussed. There is a positive relationship between $PassMil/Veh$ and %Cancelled. Agencies with relatively high cancellation rates have a greater $PassMil/Veh$ value than agencies with relatively low cancellation rates. The difference between an agency with 6% cancellations and an agency with 15% cancellations is 6500 miles/vehicle. We believe that this impact may be related to the no–shows relationship described above. There is also a negative relationship between $PassMil/Veh$ and Zones. Agencies that use zones have a mean $PassMil/Veh$ value of 30600 miles/vehicle, while agencies that do not use zones have a mean of 36300 miles/vehicle. The use of zones is unproductive because it creates situations in which vehicles travel into an area where they are not allowed to make a pick–up and must deadhead back into their assigned zone.

For the 2001 data, there are also two additional relationships to discuss. There is a negative relationship between $PassMil/Veh$ and Manual Revised. Agencies that revise routes manually on the day of use have a mean $PassMil/Veh$ value of 35300 miles/vehicle, while agencies that do not revise manually have a mean of 57400 miles/vehicle. Manual revisions to vehicle routes during the day of use are likely to be unproductive because it is difficult for humans to correctly evaluate system–wide impacts quickly without computational aids. There is a negative relationship with Service Mileage. Agencies that pay contracted service providers on a mileage basis have a mean $PassMil/Veh$ value of 36900 miles/vehicle, while agencies that do not pay contractors on a mileage basis have a mean of 37900 miles/vehicle. We interpret this impact as being the result of contractors who are paid on a mileage basis tending to drive more unloaded miles than necessary in order to increase charges to agencies.

The R–sq(adj) values for the 1998 and 1999 analyses in our previous study were 7% and 15% respectively. (No significant terms for the previous study's 1997 data corresponds to 0% R-sq(adj).) The R-sq(adj) metric indicates the percentage of the observed variance in the performance measure that is attributable to the significant variables. The analysis results for the current study show that we have been able to identify variables that account for a greater portion of the observed performance variance than previously was the case.

The next analysis was for relationships to the $Trip/Veh$ productivity measure. The scaling for

Table 12: Passenger Trips per Vehicle Regression Results

y: $(ScaledLoading + 3)^{0.5}$

	1997		1998		1999	
Term	Coeff. Est.	p–value	Coeff. Est.	p–value	Coeff. Est.	p–value
Manual Revised	−0.32	0.000	−0.21	0.001	—	—
Auto. Grouped	—	—	—	—	0.26	0.001
Complaints	0.16	0.025	—	—	—	—
Productivity	—	—	0.14	0.011	—	—
Ridesharing	—	—	0.09	0.035	—	—
Same Day	—	—	—	—	0.37	0.000
%No–shows	—	—	—	—	4.35	0.000
Longest Notice	—	—	—	—	−0.02	0.003
Zones	—	—	—	—	−0.23	0.006
R–sq(adj)	30%		30%		58%	

the 2002 data is shown in Equation 3. The Box–Cox power transformation exponent was selected to be $\lambda = 0.5$ for all years of NTD data. Tables 12 and 13 show all of the terms that were found to be significant at the 4% level.

$$ScaledLoading = \frac{Trip/Veh - 4800.9}{2267.4} \tag{3}$$

Table 13: Passenger Trips per Vehicle Regression Results

y: $(ScaledLoading + 3)^{0.5}$

	2000		2001		2002	
Term	Coeff. Est.	p–value	Coeff. Est.	p–value	Coeff. Est.	p–value
Manual Revised	−0.28	0.000	−0.48	0.001	−0.29	0.026
Auto. Grouped	0.20	0.003	—	—	—	—
Productivity	0.21	0.000	0.28	0.014	—	—
Other	—	—	—	—	0.23	0.002
R–sq(adj)	49%		36%		20%	

The most consistent relationship to $Trips/Veh$ is that with Manual Revised. This relationship is observed in all years except 1999. The sense of the relationship is negative. Agencies that manually revise routes on the day of use have a smaller $Trips/Veh$ value than those that do not. For the 1997 data, agencies that Manual Revised had a mean $Trip/Veh$ value of 4510 trips/vehicle, while agencies that did not had a mean of 6230 trips/vehicle. For 1998, the means are 4400 trips/vehicle versus 5880 trips/vehicle. For 2000, the means are 4070 trips/vehicle versus 6320 trips/vehicle. For 2001, the means are 4350 trips/vehicle versus 6520 trips/vehicle. Finally, for 2002, the means are 4320 trips/vehicle versus 5510 trips/vehicle. As above, we interpret these results as an indication of the difficulty involved in manually evaluating the impact of route revisions.

In 1997, 1998, 2000, 2001, and 2002 relationships to Complaints, Productivity, and Other are observed. These are all indicators of the use of financial penalty clauses in contracts with service providers. In each case, the relationship is positive. Agencies that use the penalty clauses have a higher $Trip/Veh$ value than those that do not. For the 1997 data, agencies that used penalties linked to Complaints had a mean $Trip/Veh$ value of 5660 trips/vehicle, while agencies that did not use penalties linked to complaints had a mean of 4390 trips/vehicle. For 1998, agencies using penalties linked to Productivity had a mean of 5400 trips/vehicle and agencies that did not had a mean of 4420 trips/vehicle. For 2000 and Productivity, the means are 5800 trips/vehicle and 3770 trips/vehicle. For 2001 and Productivity, the means are 5770 trips/vehicle and 4100 trips/vehicle. For 2002 and penalties linked to Other measures, the means are 5100 trips/vehicle and 4080 trips/vehicle. Our previous study revealed no significant impact of financial penalties on $Trip/Veh$ in 1997-1999. Again, we interpret this result as an unexplained difference between the survey groups.

In 1999 and 2000 there are relationships to Auto. Grouped. This variable indicates the use of CAD software to group service requests into routes. In both years the relationship is positive. In 1999, agencies that used automatic grouping of requests had a mean of 4800 trips/vehicle and agencies that did not had a mean of 3650 trips/vehicle. In 2000, agencies that used automatic grouping of requests had a mean of 5100 trips/vehicle and agencies that did not had a mean of 4080 trips/vehicle. As above, use of CAD systems to automatically create vehicle routes is demonstrating productivity benefits.

In 1998, there is one other relationship that remains to be discussed. The Ridesharing indicator has a positive relationship to $Trips/Veh$. For agencies that use ridesharing, the mean is 4650 trips/vehicle. Agencies that do not use ridesharing have a mean of 4460 trips/vehicle. While this relationship is statistically significant, the practical importance of the impact is small.

In 1999, there are four relationships remaining to be discussed. Agencies that accept same–

day requests have a mean of 5270 trips/vehicle, while agencies that do not have a mean of 4010 trips/vehicle. Same–day requests are beneficial because they allow agencies to fill gaps in routes that are created by no–shows and cancellations. Agencies that have a relatively high no–show rate have a greater $Trips/Veh$ value than agencies that have a relatively low no–show rate. The difference between agencies with 2% no–shows and 6% no–shows is 940 trips/vehicle. We hypothesize that no–shows appear beneficial here because the service request is still tallied as an unlinked trip, and the vehicle is freed early for other pick–ups. Agencies that allow a relatively long notice for requested travel have a smaller $Trip/Veh$ value than agencies that only allow relatively short notice for advanced reservations. The difference between agencies that allow 14 days notice and those that allow only 6 days notice is 680 trips/vehicle. Allowing extended notice for advanced reservations appear to be detrimental to productivity because these requests are more likely to produce a change of request. Finally, agencies that divide their service area into zones have a mean of 4420 trips/vehicle, while agencies that do not use zones have a mean of 4690 trips/vehicle. As above, the use of zones creates deadhead segments in the vehicle route and thereby reduces the number of requests serviced.

The R–sq(adj) values for the 1997-1999 analyses in our previous study were 8%, 11%, and 13% respectively. As above, the analysis results for the current study show that we have been able to identify variables that account for a greater portion of the observed performance variance than previously was the case.

Results of analyses for relationships to the AOC measure are shown in Tables 14 and 15. The AOC measure is defined in Equation 1. A Box–Cox power transformation exponent of $\lambda = -0.5$ was selected for all years of NTD data. The tables show all terms found significant at the 4% level.

For the 1998 data, there is one relationship observed between AOC and the use of Financial Incentives. The sense of the relationship is positive, i.e. agencies that use financial incentive clauses in contracts with service providers have a greater mean AOC value than agencies that do not use incentives. The mean AOC value for responding agencies that use incentives translates to a mean $OpExp/Trip$ value of \$26.50/trip, and a mean $OpExp/PassMil$ value of \$3.80/mile. The mean AOC value for agencies that do not use incentives translates to a mean $OpExp/Trip$ value of \$19.00/trip, and a mean $OpExp/PassMil$ value of \$2.65/mile. We hypothesize that the

Table 14: Average Operating Cost Regression Results

y: $(AOC + 3)^{-0.5}$

	1997		1998		1999	
Term	Coeff. Est.	p–value	Coeff. Est.	p–value	Coeff. Est.	p–value
Financial Incentives	—	—	−0.07	0.005	—	—
Service Hours	—	—	—	—	−0.08	0.000
Productivity	—	—	—	—	0.06	0.022
R–sq(adj)			13%		22%	

addition of financial incentive clauses to contracts that already include financial penalties produces greater costs because contractors adjust their base rates to cover any losses from penalties and then expand their revenues by earning incentives.

Table 15: Average Operating Cost Regression Results

y: $(AOC + 3)^{-0.5}$

	2000		2001		2002	
Term	Coeff. Est.	p–value	Coeff. Est.	p–value	Coeff. Est.	p–value
Outside	0.04	0.031	—	—	—	—
R–sq(adj)	8%					

For the 1999 data, there are two relationships to discuss. There is a positive relationship between AOC and Service Hours. Agencies that pay contracted service providers on an hourly basis have a mean AOC value that translates to a mean $OpExp/Trip$ value of \$24.25/trip, and a mean $OpExp/PassMil$ value of \$3.10/mile. Agencies that do not pay contractors on an hourly basis have a mean AOC value that translates to a mean $OpExp/Trip$ value of \$16.10/trip, and a mean $OpExp/PassMil$ value of \$2.05/mile. We interpret paying contractors on an hourly basis to be detrimental because drivers are paid for idle time. There is a negative relationship between AOC and Productivity. Agencies that use financial penalty clauses linked to productivity have a lower mean AOC value than those that do not. The mean AOC for agencies that use productivity penalties translates to a mean $OpExp/Trip$ value of \$18.50/trip, and a mean $OpExp/PassMil$ value of \$2.35/mile. The mean AOC for agencies that do not use productivity penalties translates to a mean $OpExp/Trip$ value of \$20.60/trip, and a mean $OpExp/PassMil$ value of \$2.65/mile. Our previous study found the use of financial penalties to produce increased costs in the 1999 data.

This contradictory result may be the complementary cost benefit to the productivity impacts noted above, and therefore remains as an unexplained difference between the survey groups.

For the 2000 data, there is a negative relationship between AOC and the practice of allowing requests for travel Outside the boundaries of the local fixed–route bus service. The mean AOC for agencies that do service such requests translates to a mean $OpExp/Trip$ value of \$17.60/trip, and a mean $OpExp/PassMil$ value of \$2.15/mile. The mean AOC for agencies that do not accept request for travel outside the fixed–route bus boundaries translates to a mean $OpExp/Trip$ value of \$22.75/trip, and a mean $OpExp/PassMil$ value of \$2.90/mile. Since agencies are not required to accept requests for travel outside the boundaries of the local fixed–route bus service area, we assume that agencies choose to do so in order to achieve cost recovery.

The R–sq(adj) values for the 1998 and 1999 analyses in our previous study were 7% and 4% respectively. No significant terms were found for the previous study's 1997 data. The analysis results for the current study indicate that while there has been some improvement in accounting for the observed performance variance, we have not been able to identify as many important variables related to operating costs as we have found for productivity.

The analyses above compare the average performance of several agencies that have a given characteristic against the average performance of several other agencies that do not have the characteristic. It is possible that the differences in performance from agency–to–agency obscure or enhance the observed impacts. A before vs. after analysis for individual agencies would eliminate such agency–to–agency differences.

A before vs. after (paired comparison) analysis was performed for agencies that implemented any of the management practices shown in Table 3 or advanced technologies shown in Table 5 during 1998-2001. Each of the four performance measures ($OpExp/Trip$, $OpExp/PassMil$, $PassMil/Veh$, and $Trip/Veh$) was investigated separately. As above, performance in the reported year of implementation was ignored because it could not be attributed to either the before or after condition. The difference in performance between the year following implementation and the year preceeding implementation was calculated as the impact of the technology/practice. The average of the differences was then evaluated for statistical significance. None of the averages demonstrated significance at the 5% level. This is most likely due to the large amount of variablility in year–to–year results for individual agencies caused by a variety of as yet uninvestigated factors.

4 Conclusions

We have conducted a survey of transit agencies providing DRT service in medium sized and large urban centers throughout the United States. The survey has provided information regarding the implementation of advanced technologies and management practices for 67 agencies that responded. We have evaluated the impact of 28 operations variables on productivity and operating cost measures derived from information available in the 1997-2002 NTD.

Our analysis indicates that use of a Paratransit CAD system to group service requests into vehicle routes provides a productivity benefit of approximately 12000 passenger miles per vehicle, and 1100 trips per vehicle, annually. However, there is no corresponding cost impact. These results suggest that policy makers should continue to implement Paratransit CAD systems, but should also monitor cost impacts that offset the expected benefits from productivity improvement. The practice of manually revising routes during the time of service produces a detrimental impact on productivity of approximately 1800 trips per vehicle annually. Policy makers should insist on some form of computational assistance for dispatchers, so that system–wide impacts of route revisions can be evaluated correctly in real time.

No–shows are identified as having a beneficial impact on productivity of approximately 10500 passenger miles per vehicle annually. This is a misleading result that is produced by a deficiency in the $PassMil/Veh$ performance measure. Agencies should not attempt to increase their no–show rates. There is a need to identify more reliable measures of productivity that can be readily estimated.

The use of financial penalties was found to have benefical impacts on productivity and operating cost. This result is in conflict with the results of our previous study. We note that there are few agencies in common between the responders to the two surveys and attribute this apparent flip–flop in results to an as yet unidentified distinction between the two survey groups.

The portion of productivity performance variability explained by surveyed variables has increased substantially from the 10% level of the previous study. However, we stand at only about 40% of the productivity variability explained. The search to identify important variables related to operating cost has been less successful. Only about 10% of operating cost variability is explained, compared to about 5% previously. There is a need for further research to identify characteristics that determine performance.

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A Survey Form

Demand Responsive Transit Service Survey

NTD ID Number:
Agency Name:

Operational Characteristics

Is your service area divided into zones that limit where a particular provider may pick-up a customer?
_____ Yes _____ No

If yes, how many distinct zones? __________

Is scheduling coordinated across the zones? _____ Yes _____ No

Do you accept standing reservations? _____ Yes _____ No

Do you accept advanced reservations? _____ Yes _____ No

If yes, what is the longest notice for which a customer may request a pick-up? __________

Do you handle same-day requests? _____ Yes _____ No

If yes, what is the shortest notice for which a customer may request a pick-up? __________

Does you accept requests for travel outside the boundaries of the local fixed-route bus service?
_____ Yes _____ No

What percentage of service requests does your agency handle by directly operated vehicle? _____

On what basis are contracted providers paid?
_____ Service requests _____ Service hours _____ Service mileage

Are drivers considered employees or independent contractors? __________

What percentage of your service requests do customers cancel after routes are planned? _____

What percentage of your service requests do customers fail to show for the pick-up? _____

How do you deal with reservations for return travel when the outbound reservation produces a customer no-show?

How are customers impacted when they produce no-shows?
_____ No impact _____ Phone call _____ Letter
Other (please specify): ___________________________

Management Practices

For each practice in use, please indicate the year that the practice was first implemented.
If the year is uncertain, please indicate an estimate with an asterisk, eg: 2001*

_____ Financial penalties – charges to contractors, deducted from the base fee, contingent upon service performance results

_____ Financial incentives – payments to contractors, in addition to the base fee, contingent upon service performance results

_____ Ridesharing – a vehicle simultaneously serves trip requests from more than one customer by use of a carpooling strategy

_____ Agency administration – the agency named on the survey performs the following functions: determines ADA eligibility, arranges for use of vehicles and services of drivers, monitors service performance, and distributes funds in payment for transportation

_____ Contracted administration – the agency named on the survey contracts another organization(s) to perform the functions listed above

_____ Consumer choice – customers are allowed a selection of providers (among the agency and its contractors) to service a trip request

Implementation of Financial Penalties/Incentives

What performance measures does your agency link to financial incentives?

_____ On-time pick-ups _____ Productivity _____ Customer complaints
_____ Driver turnover Other (please specify): ______________________________

How often are incentives awarded?

What performance measures does your agency link to financial penalties?

_____ On-time pick-ups _____ Productivity _____ Customer complaints
_____ Driver turnover Other (please specify): ______________________________

How often are penalties assessed?

What are the limits of your on-time window?

Earliest arrival before requested pick-up: _______

Latest arrival after requested pick-up: _______

Advanced Technologies

For each technology in use, please indicate the year that the technology was first implemented. If the year is uncertain, please indicate an estimate with an asterisk, eg: 2001*

_____ Advanced communications – digital radio or wireless personal communication systems used to transmit voice and/or data between the vehicle and the dispatch center

_____ Automated vehicle location – computer-based tracking system that includes a method of determining vehicle location (such as global positioning system, active signposts, ground-based radio) and a method of transmitting data from the vehicle to the dispatch center

_____ Automated fare payment – a system that allows customers to use magnetic stripe cards, smart cards, credit cards, or debit cards for fare payment via in-vehicle readers, telephone, or the internet

_____ Automated transit information – a computer-based system for disseminating real-time information (such as vehicle location or anticipated arrival times) to customers via kiosks, the internet, on-board voice annunciators, or interactive telephone systems

_____ Paratransit CAD system – single software package, or integrated collection of software products, that provide Computer-Aided Dispatching capabilities such as scheduling, routing, and dispatching.

Uses of Computer-Aided Dispatching

How are service requests grouped into routes for each vehicle?
_____ Manually _____ Automatically, by using a CAD software

If routes are created automatically, does dispatch staff revise the routes manually before use?
_____ Yes _____ No

How are routes revised during the time of use?
_____ Manually _____ Automatically, by using a CAD software
Other (please specify): ___________________

How long in advance are routes planned?

Over what period of time is a route planned to occur?
_____ Full-day _____ Half-day
Other (please specify): ___________________

What is the amount of requests given to a driver at one time?
_____ Full-day _____ Half-day _____ One-at-a-time
Other (please specify): ___________________