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## Smart Dial-A-Ride for Demand-Responsive Transit Operations: Research and Development of a Concept of Operations



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# **Smart Dial-A-Ride for Demand-Responsive Transit Operations: Research and Development of a Concept of Operations**

## **Project Report**

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The Leonard Transportation Center

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Cornelius Nuworsoo is the Principal Investigator. He prepared the study proposal, conducted day-to-day project management and coordination of all tasks, performed much of the analyses, wrote sections and compiled the study report.

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### **Key Words**

Demand response transit, Dial-A-Ride, paratransit, reservation, scheduling, dispatch, routing, efficiency, effectiveness. productivity

## Summary of Key Findings

### ***The Smart Dial-A-Ride Study***

This project investigated the conceptual basis for an efficient system to aid several areas of Dial-A-Ride operations including: (a) taking and scheduling ride reservations, (b) assigning rides to vehicles, (c) optimizing vehicle routing, and (d) automatically generating reports to characterize system operation and ridership.

The study involved field observations and interviews with demand response operators and analysis of the efficiency and effectiveness of operations using data supplied or reported to the National Transit Database by the agencies. Findings from both field investigations and the literature are used in the development of a concept of operations aimed at improving operational efficiency and effectiveness.

### ***Origin of the Study***

This project is a follow-up to a 2009 Senior Mobility Study that was funded by the Leonard Transportation Center. Survey results from the previous study revealed that: (a) twice as many seniors (24%) would prefer public transportation in the form of buses, trains and Dial-A-Ride as those that actually used these modes (11%); and (b) dial-a ride would be particularly preferred as it would quadruple the existing level of choice from 3% to 12%, matching the use of conventional fixed route transit (Nuworsoo et al, 2009).

### ***Best Practices in Demand Response Transit (DRT) Operations***

The Federal Transit Administration (FTA) categorizes three types of demand-response transit (DRT) services under "Dial-A-Ride". They are: (a) general public DRT; (b) specialized or limited eligibility DRT; and (c) ADA paratransit services. The FTA therefore defines DRT as "a transit mode comprised of passenger cars, vans or small buses operating in response to calls from passengers or their agents to the transit operator, who then dispatches a vehicle to pick up the passengers and transport them to their destinations" (TCRP 124, 2008, p4; TCRP 136, 2009, p3).

### **Key Functions**

The literature recommends certain best practices according to the key functions of Dial-A-Ride operations (Goodwill and Carapella, 2008; Pagano et al, 2000; Lave et al, 1996). These are outlined as follows:

#### *Reservations*

- Give reservationists the authority to negotiate pick-up and drop-off times.
- Establish and discuss actual pick-up time versus appointment times during reservations.

- Verify the passenger’s information during the reservation process.
- Develop a rider guide to effectively communicate the reservation process and policies regarding pick-up and drop-off windows to riders.
- Provide pre-scheduled subscription service trips, or trips that a patron makes multiple times per month, often multiple times per week and are of a specific origin and destination that does not change in order to reduce the burden on the call intake system.

### *Scheduling*

- Enable the review and revision of the schedule generated by the automated system by experienced employees to ensure that necessary adjustments are made.
- Provide reminder phone calls to passengers prior to their scheduled trips in order to reduce no-shows and late cancelation rates.
- Permit same day scheduling of trips to lower pent up demand and reduce the practice of some passengers booking extra trips in order to keep their future travel options open and later canceling unneeded trips.

### *Dispatching*

- Provide on-call dispatchers to deal with any changes or disruptions to service and enable direct communication between vehicles and dispatch operators.
- Have a policy process in place to monitor where the operators are during the daily schedule. Some agencies follow routines where the vehicle operator checks in with the dispatcher at each pick-up and drop-off location. Often, large systems follow a routine where vehicle operators contact the dispatch center only in the event of a problem (e.g. passenger running late or does not show up), so that dispatchers can make the necessary adjustments to the schedule.

### *Reporting and Monitoring*

- Develop a service performance system to measure a variety of elements including the call in-take process, on-time performance, vehicle readiness, no-shows, productivity measures, etc.
- Establish and continuously maintain a formal system to monitor complaints and compliments. Investigate and respond to all complaints in a timely manner.

### **The Autonomous Dial-A-Ride Technology (ADART)**

The most promising embodiment of most features of recommended best practice is the Autonomous Dial-A-Ride Technology (ADART), a computerized, fully automated demand responsive system that operates without any centralized command and control. ADART is not

widely implemented because it lacks the human contact element which made it lose community acceptance. A similar system with the option for users to interact with reservationists would make for a smart Dial-A-Ride system.

### ***Findings from Field Interviews***

Nine DRT operators in California were interviewed to elicit responses on the how and the why of adopted operational practices. The agencies were selected to include varying sizes of operations, geographic coverage and whether DRT service is provided to the public or restricted to qualifying riders. Key revelations include the following:

- All operators assigned time blocks (of 15 to 30 minutes) for pick-up and drop-off of passengers.
- The most common causes for disruption of service schedules are late trip cancellations or no-shows by patrons. High rates of these occurrences result in large decreases in efficiency and productivity
- Most operators accepted same-day reservations, but all declined subscription for service. There were two main reasons for not allowing subscription services: one is that if it was allowed then the DRT services would be booked weekly and would not have room for the general public and other users; the other reason is that it would complicate scheduling.
- All operators interviewed route vehicles according to the sequential pick-up/nearest drop-off routine regardless of whether the agency had a CASD system or not.
- Operators with on-board mobile data terminal (MDT) units in the vehicles significantly reduced the amount of communications required between dispatchers and drivers.
- Operators interviewed expressed the desire to keep radio contact to a minimum and preferred to use the MDTs for the majority of communication in order to minimize driver distraction and maximize efficiency.
- DRT operators that used some sort of computer-aided scheduling and dispatch (CASD) system show significant reduction in operating cost per vehicle mile over those who did not because CASD helped improve vehicle routing, which boosted the number of shared trips and reduced the amount of extra or single trip miles.
- All CASD system users expressed some frustration with the programs. This suggests that there is room for improvement in designing a CASD system that is specifically calibrated for DRT operations.

## ***Recommendations for a Smart Dial-A-Ride System***

This study recommends that a smart DRT system includes certain features. These are outlined as follows:

- The CASD systems on the market provide the ability to perform many of the functions in the best practice recommendations and operator preferences yet they are not used to their full potential. In order to create a CASD system that will be used to its greatest potential a combination of extensive training and an intuitive and easy to use interface are necessary.
- Functions should be as completely automated as possible to reduce the load on human resources, but the system should be flexible enough for reservationists and dispatchers to intervene.
- Customers should have the option for human interaction if the automated system does not seem to work for them or if they happen to be new users in need of help.
- It is apparent that a system that serves the public at large is beneficial as it would widen the pool of potential riders for a given amount of vehicle service hours. Serving a relatively large geographic area is closely related to widening the pool of potential riders. However, when travel distances begin to limit the number of passengers handled, the area can be broken into sub-units as is done for instance by the Fillmore system in Ventura County.
- To gain the most from vehicle reporting functions it is suggested that systems are able to collect real-time operational data.

## ***Concept of Operations***

Smart Dial-A-Ride is envisioned as a widely available, community-wide vehicle sharing scheme. It would consist of a widely deployed, real-time automated van and small bus scheduling system that is similar to the ADART system, but with the distinct difference that it has the ready option for human interaction during all phases of its operation. The goal is “a ubiquitous shared-vehicle system capable of door-to-door and connector service available to the broad population of residents”. All service would be reservation-based, but with enough flexibility to accommodate those who require service at short notice. It would include arrangements with local taxi operators for transfer of demand overload. It should be organized as a regional system under which sub-area services are offered for optimality, similar to the way DRT is operated, for instance, by the Fillmore system in Ventura County. Section 7 has the full description of the concept of operations.

# **1.0 Introduction**

## **1.1 The Smart Dial-A Ride Study**

### **Objective**

This project investigated the conceptual basis for an efficient system to aid several areas of Dial-A-Ride operations including: (a) taking ride reservations, (b) assigning rides to vehicles, (c) optimizing vehicle routing, and (d) automatically generating reports to characterize system operation and ridership.

### **Scope**

This study covers one of a two-part project envisioned to analyze Dial-A-Ride operations and develop a concept of operations for a Dispatch Assistance Tool (DAT). This study is thus part of a coordinated set of projects by two teams working cooperatively at Cal Poly San Luis Obispo. While this part researched and developed the concept of operations, the companion project researched and developed the prototype tool.

Work on the topic of “smart Dial-A-Ride” is envisioned to fall logically into three phases. The joint projects constitute the first of three phases. Subsequent phases are envisioned to cover test deployment and evaluation respectively. It is also envisioned that a successful system would be commercialized to disseminate the product to the transit community.

### **Method**

The study involved field observations and interviews with demand response operators and analysis of the efficiency and effectiveness of operations. Findings from both field investigations and the literature are used in the development of a concept of operations to improve operational efficiency and effectiveness using data supplied or reported to the National Transit Database by the agencies. The product from this part of the project includes a set of recommendations for designing and implementing a smart Dial-A-Ride system. This information was passed on to the companion project for the development of the prototype tool.

## **1.2 Background**

There are an estimated 2,100 contracted Dial-A-Ride operators in the United States. While data is only available for about a quarter of these operators in the Federal Transit Administration’s National Transit Database (NTD), the reported figures are significant - over 90 million rides given per year, with almost 800 million passenger miles traveled. Surveys of seniors under a 2009 Senior Mobility Study that was funded by the Leonard Transportation Center produced two key revelations as follows (Nuworsoo et al, 2009):

1. Twice as many seniors (24%) would prefer public transportation in the form of buses, trains and Dial-A-Ride as those that actually do use these modes (11%).
2. Dial-a ride would be particularly preferred as it would quadruple the existing level of choice from 3% to 12%, matching the use of conventional fixed route transit. This suggests the need to revamp Dial-A-Ride service to be more efficient and more available as the population of seniors is projected to grow in the coming decades.

Many Dial-A-Ride service providers often make ride reservations and dispatch vehicles using manual dispatch methods which are tedious, labor intensive, and often fail to provide in whole or in part an easily accessible official record of operations and rides given or denied. Manual vehicle dispatch also requires a highly skilled operator to be effective, as he or she is required to keep track of many pieces of information whilst managing regular operations and balancing customer needs with vehicle routing and availability to provide proper service. The process leaves a paper trail of records that is cumbersome to revisit and analyze for performance evaluation and planning.

From an operational standpoint of an operator on the Central Coast of California, for instance, service is often provided in a fashion in which riders must make a reservation at least two hours ahead of time, giving (a) pick-up location; (b) desired time of pick-up; (c) desired destination, all of which are recorded on individual pieces of paper. A rider is scheduled into the closest available 15-minute “slot” for desired pick-up time. More than one passenger may be picked up on a run resulting in a few passengers on board at the same time. While efforts are



made to dispatch as well as personnel could handle, passengers are often dropped off to destinations in a first in, first out (FIFO) order – according to order of scheduling in time slots. This can result in the vehicle passing by another passenger’s drop-off locations as it continues to the destination of the first passenger. This method of operation can result in inefficient service as it can limit the number of passengers handled (or “system capacity”) per time period, and result in additional operational costs due to the extra miles travelled.

A comparative study of public transit modes in California revealed that Dial-A-Ride transit appears to be the least utilized, the least productive and the most subsidized of all the transit modes. The average subsidy per ride by Dial-A-Ride service was \$6 compared to the average per ride of \$3 for fixed route transit (Nuworsoo, 2001, unpublished). Providers face operating costs that can exceed \$40 per vehicle per hour, of which material expenses such as fuel account for almost ten percent of total costs. These facts need to be reconciled with the finding that seniors would prefer Dial-A-Ride more than any other public transportation mode. The quantity of Dial-A-Ride vehicles in service coupled with diminishing resources and rising costs make it imperative to maximize the efficiency and optimize the customer experience. Efficient travel is not only important to passengers utilizing Dial-A-Ride services, it is also essential to the operator’s bottom line.

Various commercial solutions exist (e.g. Trapeze, and RouteMatch) which automate dispatching and attempt to improve operational efficiencies for Dial-A-Ride operations. Although these commercial solutions may be effective, they can be extremely cost prohibitive to small and medium size Dial-A-Ride operations. Investigations reveal that these costs average several hundred thousand dollars for installation and are usually accompanied by maintenance and support costs that range from five to fifty thousand dollars per year.

An inexpensive solution is desired and possible due to the advent of easy to use tools such as Google Maps, which enable the development of capable geographic information systems (GIS) tools with modest effort that can assist dispatchers in effective route planning and management. Additionally, various open-source applications have demonstrated their utility, hence making this an attractive mechanism for deploying an application such as this to

smaller transit properties. This project seeks to take advantage of these available technical resources to research and demonstrate the feasibility of an inexpensive demand response dispatch tool.

Dial-A-Ride dispatching is a skill which can take years to build and hone. A dispatching tool which can aid new dispatchers in making good decisions and hence effectively dispatching their fleet has the potential to reduce agency costs due to reduced training time.

A real-time scheduling and routing program can help improve operations. Besides, smart Dial-A-Ride has the potential to help a wide variety of users transition from over dependency on the automobile for most travel needs to (a) obtaining improved connectivity to line-haul services provided by fixed-route lines; and (b) substituting for short drive trips that are either impractical to walk or bike because of separation of activity centers or for which existing fixed route service is non-existent or cumbersome to use.

At the neighborhood or community level, an efficient and widely available Dial-A-Ride system may be viewed as an advanced form of car sharing that can serve the niche between the private automobile and fixed route service while society attempts to change land use patterns to more compact forms that support fixed route service.

## 2.0 Review of Literature

### 2.1 Demand-Response Services

On-demand services generally provide *door-to-door transportation*. There is no fixed route and people call for service when the need arises. These services are usually provided with a shuttle or a van and can be operated privately or publicly. There are a few variations of this service. People with limited mobility sometimes need help getting from the doors of their residences to shuttles (referred to as door-through-door service). Other services are considered curb-to-curb, where customers are able to walk to a curb, perhaps not a bus stop. These services can also be used as a feeder to larger transportation systems offering pick up at any location and drop off at a transit station. This can be used for those who live too far from a bus stop to walk or bike, but not for those cases where mobility is very limited. Some of these services are made to serve only seniors, low-income groups, or the disabled. For seniors, a “many-to-few” service may pick up at any location, and drop off at a senior center or grocery store. The commonest example of door-to-door service in the US is Dial-A-Ride.

Private automobiles provide another form of door-to-door service, though they provide *private* rather than public transportation. Taxi-use is often encouraged for seniors who can no longer drive, but is not feasible for all seniors, especially those with limited incomes. There are two major systems that have been developed to pay for taxis: taxi reimbursement and taxi voucher systems. Though both of these systems allow seniors to use taxis, one enables seniors to pay with a voucher while the other requires seniors to pay out of pocket initially to get reimbursed later. Often there are limits to the number of free rides a person receives within a given period of time. Both of these systems require program coordinators and can be combined with other financial programs offered for seniors. The California cities of San Francisco and Berkeley offer voucher services. The Maryland Transit Administration in Baltimore offers the reimbursement service. One alternative to the taxi system is a volunteer system, where volunteers such as neighbors drive seniors either for free or for reimbursement. The Paso Robles Senior Center in San Luis Obispo County, for instance, relies heavily on volunteers to transport seniors to various activities.

## **FTA Definition**

The Federal Transit Administration (FTA) categorizes three types of demand-response transit (DRT) services under "Dial-A-Ride". They are: (a) general public DRT; (b) specialized or limited eligibility DRT; and (c) ADA paratransit services. The FTA therefore defines DRT as follows (TCRP 124, 2008, p4; TCRP 136, 2009, p3):

“Demand-response is a transit mode comprised of passenger cars, vans or small buses operating in response to calls from passengers or their agents to the transit operator, who then dispatches a vehicle to pick up the passengers and transport them to their destinations. A demand-response (DR) operation is characterized by the following:

- a. The vehicles do not operate over a fixed-route or on a fixed-schedule except, perhaps, on a temporary basis to satisfy a special need; and
- b. Typically, the vehicle may be dispatched to pick up several passengers at different pick-up points before taking them to their respective destinations and may even be interrupted en route to these destinations to pick up other passengers.”

This definition captures the essence of Dial-A-Ride services included in this study.

## **Urban DRT vs. Rural DRT**

A distinction between urban and rural DRT is important in light of revelations in the literature that more than half of all seniors (56 percent) already live in the suburbs with the remainder shared nearly equally between rural and urban areas (Rosenbloom, 2003). Thus more than three quarters of all seniors live in lower density rural and suburban areas.

The Transit Cooperative Research Project (TCRP) Report 136 provides distinctions between urban and rural DRT operations. It recognizes that "DRT in rural areas is often more than just a fleet of smaller vehicles operating in response to calls from passengers or their agents." Rural (and sometimes suburban) DRT service may exhibit the following features (TCRP 136, 2009, p4):

- Provide scheduled service one day each week to and from a distant medical center with advance reservations.

- Serve outlying communities only two or three times per week, with a morning trip into the larger town and a return trip in the afternoon each day of service.
- Provide service for clients of local human service agencies on a contractual arrangement.
- Carry more than just passengers. Rural DRT may transport meals to home-bound seniors as part of its transportation mission. A rural system may carry bulk mail for the U.S. Postal Service in addition to passengers. Such non-passenger transportation service is allowed for rural providers through the FTA's Section 5311 Program as long as such service does not reduce the availability of public transportation service.

While rural DRT may be some or all of these services in particular rural communities, they share the common characteristic of requiring the reservation of trips, which is "demanding" for service. Reservation could be made when an individual books a trip for subscription service or it could be made by a sponsoring human service agency for the rider. Nevertheless, it is the act of reserving a trip that distinguishes DRT from traditional fixed-route, fixed-schedule service.

TCRP 136 (2009) further distinguishes rural DRT from urban DRT by the broad range of DRT systems and services that are classified as "rural." Differentiations of rural services are based on sponsoring organization, clientele served, the range of services provided, funding sources used, and service areas within which rural systems operate.

"In terms of sponsoring organizations, for instance, rural DRT is provided by political subdivisions, regional entities, transit districts, Councils of Governments (COGs), various single purpose and multi-purpose non-profit human service agencies, and Native American tribal organizations. In terms of service area, there are rural DRT systems that operate within more than 10,000 square miles, sometimes with rugged terrain and limited roadways and many characterized by different "micro-climates" given the large size and varying elevations that affect daily operations. Many systems serve not just their rural communities and counties, but travel long distances to large urban centers for medical trips, with such trips perhaps requiring an 8- to 10-hr day given the distances to be traveled and time required for riders' appointments" (TCRP 136, p4).

The following subsections discuss the individual components of Dial-A-Ride operation. The nature and manner of application of these components contribute to costs and ultimately the performance of operations.

## **2.2 Computer-Aided Scheduling and Dispatch Service Components**

The various components of Dial-A-Ride operation are generally grouped under the term, Computer-Aided Scheduling and Dispatch (CASD) systems, which often vary in the functions that they provide. The literature identifies certain essential service components that these systems should include. Lave, et al. (1996) suggest five categories of software functions: reservations, scheduling, dispatching, routing and reporting. Similarly, Goodwill and Carapella (2008) contend that with a well-coordinated reservation/scheduling/dispatch process and a good communications system, agencies are better able to control the ever increasing costs of providing paratransit services. This study therefore focuses on these five components of operations.

### **Trip Reservations**

Reservation functions are essential components of an efficient CASD system. The reservation process relies on the interaction between a reservationist and the patron scheduling the pick-up, in which the paratransit representative collects and records the information necessary to schedule the trip. This process is sometimes streamlined with the incorporation of automated reservation technologies. An agency usually defines its policy on pick-up and drop-off windows within the riders guide. The policies are designed to give the transit operator a small amount of leeway in travel and scheduled pick-up time, usually about 15 to 30 minutes (Goodwill and Carapella, 2008). A CASD software system that stores the customer information and that can be easily accessed by paratransit reservationists during the reservation process could lead to time savings and a more efficient reservation process. The storage of customer information is also a valuable component in the implementation of subscription service trips, which are scheduled trips that a patron makes multiple times per month or per week and are of a specific origin and destination that does not change. Automated phone systems are another CASD system

function that allows for reminders or verification calls to the patron on the day or the day prior to travel. Such practices have been shown to greatly cut down the number of no-shows and many agencies report enhancement in the daily operations of the paratransit system (Goodwill and Carapella, 2008).

A feature that could be considered its own distinct category but is often tied to trip reservations is determination of eligibility. This applies to those paratransit systems for which prospective patrons must meet certain eligibility criteria before they are permitted to use the system. The criteria may relate to age, physical condition, agency affiliation and ADA certification. Lave et al (1996) contend that CASD software must be capable of determining the eligibility of the prospective rider at the time that the request for service is placed. This requires a database of customers and their previously established eligibility that can be quickly and easily found by reservationists.

### **Vehicle Scheduling**

Vehicle scheduling is the process of developing a timeline for pick-ups and drop-offs to meet the requests of patrons within the constraints of the schedules of passengers and the provider of the paratransit service. This is an especially challenging aspect because of the need to accommodate new trip requests as well as the pre-existing orders. Incorporation of a fully automated vehicle scheduling system enables each day's schedule to be automatically developed by computer software, which is then managed and reviewed by the paratransit operators. For many providers with or without CASD systems, scheduling is an interactive and dynamic process between the customer and the provider, requiring more than one cycle of proposed and rejected pick-up or drop-off times (Pagano et al, 2000). The computer generates a trip manifest of scheduled trips which the transit operator reviews for reasonableness. Mobile Data Terminals (MDT) within individual vehicles enable manifests to be viewed in electronic form and in real time by vehicle operators. The manifest shows each individual vehicle operator the daily pick-up and drop-off schedule.

## Vehicle Dispatching

Vehicle dispatching is the process of assigning vehicles to previously scheduled requests for transportation. This aspect of the CASD system serves as the operation center for paratransit operations where dispatchers must be able to address unforeseen issues or interruptions to service that could potentially detract from the paratransit system's efficiency and timeliness. Essential to this function is the ability to know the status and location of all vehicles and operators at all times.

Some agencies have systems where the vehicle operator checks in with the dispatcher at each pick-up and drop-off location thereby providing an open line of communication and alerts to the dispatch center on any abnormalities the operator may be facing (such as running late, having arrived too early, or if a patron does not show) and allows the dispatcher to make schedule adjustments as necessary (Goodwill and Carapella, 2008). This type of frequent contact is difficult in a larger system because of the number of vehicles in operation at one time. A 1996 survey of paratransit fleet size operators (TCRP Report 18, 1996) found that size affects the use of computers in dispatching. Most systems with 16 to 22 vehicles used computers in dispatching and all systems with more than 36 vehicles did so (Lave and Mathias, 1996). Larger systems often use a system in which vehicle operators only contact dispatch in the event of an issue.

Advances in technology such as mobile data terminals and automated vehicle location equipment allow for dispatchers to know the precise location of every vehicle at all times. This allows for tweaks in the schedule to occur in real time, and often before issues arise (Goodwill and Carapella, 2008).

In a computerized system it is most efficient to perform scheduling and dispatching in unison. One of the advantages of computerization is to perform the functions jointly so that the times promised to patrons are based on dispatching, that is, the assignment of the trip to an actual vehicle (Lave et al, 1996).



### Vehicle Routing

The routing function finds the best route between pickup and drop-off points in terms of the sequence of actual roads taken. The routing function (generally integrated into the same algorithm as the scheduling function) is based on sophisticated mathematical optimization techniques (Pagano et al, 2000). The solution can be performed by a number of mathematical procedures, but performing routing in a system of a practical size requires automation (Lave et al, 1996).

### Monitoring and Reporting

The implementation of CASD systems not only allows efficiency gains as detailed above, it also increases the efficiency of paratransit agencies in terms of internal management. The automation and storage of passenger data enables the generation of billing reports, the ability to call up on demand reports to search for passengers with high no-show rates, the computation of average time to accomplish scheduling of passenger trip requests, and following-up on complaints, which can provide a quantum leap in management effectiveness (Pagano et al, 2000). Management reporting, which includes collecting data on all major system processes and analyzing that data provides system managers with indicators of the efficiency and effectiveness of the different processes performed by the system (Lave et al, 1996). To gain the most from vehicle reporting functions it is suggested that systems are able to collect real-time operational data.

## 2.3 Typical Problems with Implementing CASD Systems

The 1996 *TCRP Report 18: A Handbook for Acquiring Demand-Responsive Transit Software* “was designed to assist DRT providers with assessing software needs for automating DRT management and operations functions, assist in procuring software to meet those needs, and develop software specifications for each of the functions” (TCRP Report 18, 1996). The report includes a synthesis of the implementation issues and problems to be aware of with regards to CASD systems. They include the following:

- Recognition that implementation takes time so that patience must be exercised.
- The skills of the DRT staff may need to be upgraded.
- Software needs to be thoroughly tested.
- Software and hardware need to be coordinated.
- Transferring data from an old system to the new one is a critical step.
- Setting of parameters (average speeds on different road links, under different conditions, and accurate mapping of the service area) may be a pitfall.
- Training on the new system should take place at the agency's site, and incentives for active participation by reluctant employees may need to be provided.

In 2001, Pagano and his associates at the University of Illinois at Chicago published their study on the effectiveness of CASD in paratransit operations. Their stated objective was to “gain insights into the processes used, problems encountered and benefits and costs experienced in implementing computer-assisted scheduling and dispatching systems” (Pagano et al, 2001). The study's major findings on major issues that arose during CASD system implementation include the following:

- One-half of the operators did not use major features of their new CASD systems. Importantly, most operators did not use one of the most lauded features, optimization.
- Operators noted gains in efficiency, effectiveness, and quality, with some reporting significant changes, but on the whole, pre- and post-implementation comparisons did not show the kind of dramatic efficiency changes that operators had hoped for.
- Training issues were significant and had seriously degraded potential positive impacts at most sites.
- The survey indicated that no vendor had provided satisfactory report generation capabilities or the training required to create and to interpret the report output.
- Operators were strongly in favor of adding a dedicated project manager to the CASD system implementation process.
- Overall, the implementation of CASD systems was positively welcomed, but few operators were able or willing to fully exploit the power of CASD technology.

These findings demonstrate the necessity for CASD systems to develop intuitive and easy to use operator and user interfaces, as well as extensive operator training on the capabilities and benefits that the CASD system offers. Those are the goals envisioned for of the smart Dial-A-Ride study.

A 2008 report by Goodwill and Carapella in which the objective was to “define types of paratransit services and their characteristics, document major paratransit expense factors and their trends, and identify and document best practices in paratransit cost containment” describes the key issues which contribute to loss of efficiency and revenue in CASD paratransit service delivery. The most common causes for disruption of service schedules are late trip cancellations or no-shows by patrons. High rates of these occurrences result in large decreases in efficiency and productivity (Goodwill and Carapella, 2008). In order to mitigate these occurrences transit agencies have developed operating practices and policies that include establishing: (a) a set procedure for reporting and documenting incidents using CASD vehicle reporting features; (b) procedures to monitor and proactively respond to patrons who exhibit such travel patterns; and (c) education of the paratransit passengers as to their responsibilities. Features of CASD systems that can also mitigate the occurrences of trip cancelations and no-shows by patrons include automated phone reminders on the day of service and establishing pick-up windows.

## **2.4 Measuring the Performance of DRT**

Demand-responsive transportation (DRT) has proven to be an expensive and less productive option than the more traditional fixed-route transit services. In order to improve upon the performance and cost-effectiveness of DRT, standardized methods of measuring and assessing performance are needed. The objective of TRCP Report 124 (2008) along with TRCP Report 136 (2009) was to develop such a resource to assist DRT systems to measure, asses, and improve performance. TRCP Report 124 is a guidebook that specifically deals with measuring, assessing and improving performance of DRT in urban environments while TRCP Report 136 focuses on the same issues but in rural settings. Adopting the performance measures put forth within

these two reports when assessing DRT agencies can provide a standard set of measures that would enable the addition and comparison of case studies to the existing set of data contained within these two guidebooks.

The 2008 study discovered more than 60 different performance measures that different agencies have used to assess DRT service. In order to concentrate on the most essential aspects of DRT system, TRCP Report 124 (2008) suggests the use of a smaller set of measures when assessing performance and cost-effectiveness. The Report recommends five key performance measures for assessing DRT as follows:

1. Passenger Trips per Revenue Hour
2. Operating Cost per Revenue Hour
3. Operating Cost per Passenger Trip
4. Safety Incidents per 100,000 Vehicle Miles
5. On-Time Performance

Each of these performance measures directly addresses the productivity or cost-effectiveness of the DRT system, which are the two areas in general which DRT falters as a feasible method of wide scale public transportation. The performance measures suggested by TRCP Report 124 are summarized and explained in the following paragraphs.

*Passenger trips per revenue hour* – this is considered by many as the most important single measure of DRT performance. TRCP Report 124 (2008) asserts that this performance measure assesses the productivity of the DRT system and captures the ability of the DRT system to schedule and serve passenger trips with similar origins, destinations, and time parameters, using the least number of in-service vehicles and revenue hours. This measure of productivity is calculated using the following equation:

$$\text{Passenger trips per revenue hour} = \text{Total passenger trips} / \text{total revenue hours}$$

*Operating cost per revenue hour* – this is considered the key cost-efficiency measure in that it establishes the financial resources needed to produce an hour of revenue service. This performance measure is calculated using the following equation:

$$\text{Operating cost per revenue hour} = \text{Total operating cost} / \text{total revenue hours}$$

*Operating cost per passenger trip* – this is an essential cost-effectiveness measure that combines the operating cost per revenue hour and the passenger trips per revenue hour in order to relate productivity to the hourly operating cost. The equation for this performance measure is as follows:

$$\text{Operating cost per passenger trip} = \text{Total operating cost} / \text{total passenger trips}$$

*Safety incidents per 100,000 vehicle miles* -- this is the performance measure recommended for assessing safety of a DRT system. The Guidebook uses NTD definitions to define and measure safety and accident rates by using the classifications of NTD major incidents and NTD non-major incidents. (TCRP Report 124, 2008, p20). Appendix 2-1 includes the definitions of incidents. The calculation for the safety performance measure uses the following equation:

$$\text{Safety incidents per 100,000 vehicle miles} = [(\text{NTD major} + \text{non-major safety incidents}) / (\text{total vehicle miles})] \times 100,000$$

*On-time performance* – this is possibly the most important measure of service quality from a DRT rider’s perspective (TRCP Report 124, 2008). On-time trips can be difficult to quantify accurately because of the varying definition of “on-time trips” from agency to agency, and the variations in the methods by which the data is collected. The calculation for this performance measure is completed using the following equation:

On-time performance = (total on-time trips, including no-shows, + early trips) / (total completed trips + no-shows + missed-trips)

TRCP Report 124 (2008) suggests that on-time performance should be calculated based on all completed trips along with no-shows and missed trips. In order for this assessment to work, standard procedures should be employed in order to make sure that no-shows are in fact actually no-shows.

There are additional performance measures that assess more specific areas of service and which impact the key performance measures outlined in the previous paragraphs. These performance measures and their corresponding equations include the following:

1. *No-Show/Late Cancellation Rate* = (total no-shows + total late cancellations) / total number of scheduled trips
2. *Cancellation Rates*
  - a. *advanced cancellation rate* = total advance cancellations / total number of reserved trips
  - b. *same day cancellation rate* = total same-day cancellations / total number of scheduled trips
3. *Missed Trip Rate* = total missed trips / total number of scheduled trips
4. *Trip Denial Rate* = total trip denials / total number of requested trips
5. *Complaint Rate* = (total valid complaints / total revenue hours) x 1,000
6. *Average Passenger Trip Length* = total passenger miles / total number of passenger trips
7. *Average Travel Time* = total passenger travel time / total number of passenger trips

## 2.5 Comparing the Performance of DRT Systems

Classification is essential in categorizing DRT services by characteristics that affect performance so that they are more appropriately compared. The literature reveals that the several criteria that influence DRT performance have been used to classify them. They include the following:

- Ridership market served
- Service area/ operating environment
- Type of routing and scheduling
- Type of operator: public vs. private contractor
- Dedicated vs. non-dedicated vehicles
- Advance request vs. immediate response
- Use of advanced technology
- Door-to-door vs. curb-to-curb
- Use of volunteers
- Provision of Medicaid transportation

TRCP Report 124 (2008) established a simplified typology of DRT systems in order to classify and more easily compare them. The recommended typology is based on two criteria, which are ridership market and service area.

*Ridership Market* -- TCRP Report 124 (2008) advances a number of reasons that explain why the performance of DRT systems serving the general public can be typically higher than systems serving specialized markets:

- "There is a larger pool of potential riders from the general public than target groups, which creates a higher density of potential demand.
- The dwell time at pick-up locations is shorter for general public riders. This includes both the established wait time, set by policy, and the time needed for rider boarding and alighting. Data from several DRT systems in the mid-1990s found that dwell times at pick-ups for ambulatory riders, which make up the large majority of general public riders, averaged 2 to 4 min, while that time for riders using wheelchairs, which may be a significant portion of the specialized rider market, was 4 to 6 minutes.
- There tend to be fewer late cancellations and no-shows at systems serving the general public as general public riders are typically less likely to cancel trips on short notice or no-show trips because of health issues and inclement weather".

*Service Area* -- TCRP Report 124 (2008) explains that service area influences DRT performance in several significant ways:

- "The number of people living in the service area; a service area with a larger population will have a larger pool of potential riders.
- geographic size, and distribution of residential areas and trip destination areas; a service area that is large geographically will tend to have longer trip lengths, and a low-density dispersion of residential areas and trip destinations across a service area will also mean longer trip lengths and less opportunity to group trips.
- Trip length is a particularly important performance factor because DRT systems can serve fewer longer trips in a given amount of time compared to shorter trips, which impacts both productivity and cost per passenger trip.
- Other aspects of the service area may also impact performance, such as geographic features influencing the ease or difficulty of travel throughout the community. In a related way, traffic congestion and the street network complexity in larger urban areas also impact performance, resulting in long travel times which limit DRT performance in the same way as long trip lengths.
- Larger urban areas may also have long trip lengths, depending on passengers' travel patterns. For larger urban areas, then, the compounding effects of traffic congestion, complicated street network, and long trip lengths put significant constraints on DRT productivity."

On the basis of service area therefore, TCRP Report 124 (2008) divided DRT systems first into rural and urban systems. Then urban systems are subdivided into three categories: (a) small urban DRT systems serve areas with populations between 50,000 and 200,000 people; (b) large urban DRT systems serve areas with populations between 200,000 and 1 million people; and (c) largest urban DRT systems serve areas with populations over 1 million people.



On the basis of ridership market, the report broke down the system within each service area into the three categories which include ADA paratransit, limited eligibility DRT, and general public DRT. ADA paratransit is a system that is designed and operated as an ADA complementary system that meets all ADA standards and can go beyond such standards. Limited eligibility DRT is defined as systems that serve specialized groups, typically senior citizens and riders with disabilities. General Public DRT is typically provided in smaller cities in place of or in combination with other local transit options.

## 2.6 Set of Best Practices and Strategies

The 2008 report *Creative Ways to Manage Paratransit Costs* by Goodwill and Caparella “defines types of paratransit services and their characteristics, documents major paratransit expense factors and their trends, and identifies and documents best practices of paratransit cost containment” (Goodwill and Carapella, 2008). The following subsections outline these recommended best practices according to the five categories of software functions suggested by Lave et al (1996), which are, reservations, scheduling, dispatching, (routing) and reporting. No best practices were included for the category of routing.

### Reservations

- Give reservationists the authority to negotiate pick-up and drop-off times.
- Establish and discuss actual pick-up time versus appointment times during reservations.
- Verify the passenger’s information during the reservation process.
- Develop a rider guide to effectively communicate the reservation process and policies regarding pick-up and drop-off windows to riders.
- Provide pre-scheduled subscription service trips, or trips that a patron makes multiple times per month, often multiple times per week and are of a specific origin and destination that does not change in order to reduce the burden on the call intake system.

### Scheduling

- Enable the review and revision of the schedule generated by the automated system by experienced employees to ensure that necessary adjustments are made.
- Provide reminder phone calls to passengers prior to their scheduled trips in order to reduce no-shows and late cancelation rates.
- Permit same day scheduling of trips to lower pent up demand and reduce the practice of some passengers booking extra trips in order to keep their future travel options open and later canceling unneeded trips.

### Dispatching

- Provide on-call dispatchers to deal with any changes or disruptions to service and enable direct communication between vehicles and dispatch operators.
- Have a policy process in place to monitor where the operators are during the daily schedule. Some agencies follow routines where the vehicle operator checks in with the dispatcher at each pick-up and drop-off location. Often, large systems follow a routine where vehicle operators contact the dispatch center only in the event of a problem (e.g. passenger running late or does not show up), so that dispatchers can make the necessary adjustments to the schedule.

### Reporting and Monitoring

- Develop a service performance system to measure a variety of elements including the call in-take process, on-time performance, vehicle readiness, no-shows, productivity measures, etc.
- Establish and continuously maintain a formal system to monitor complaints and compliments. Investigate and respond to all complaints in a timely manner.

## **2.7 State of the Art Technology**

Paratransit services can benefit from the integration of state-of-the art-technology. New technology has been introduced into CASD systems in a piecemeal fashion into the different essential categories of reservations, scheduling, and dispatching. Some of these technologies

include sophisticated telephone system, state-of-the-art vehicle communication system, reservation and scheduling computer software systems, Automatic Vehicle Locator (AVL) systems, and Mobile Data Terminal (MDT) systems which can be individually assessed according to the category of the paratransit system that they serve. A new Autonomous Dial-A-Ride Technology (ADART) employs fully-automated order-entry and routing-and-scheduling systems that reside exclusively on board the vehicle and the customer is the only human involved in the entire process of requesting a ride, assigning trips, scheduling arrivals and routing the vehicle.

### Reservations

The use of sophisticated telephone services can help improve telephone access and service during the reservation process. Features such as automatic call distribution spreads the calls evenly to the in-take personnel and allows for monitoring of performance such as average time waiting, average call length once connected, dropped calls, and other key performance measures (Goodwill and Carapella, 2008). More advanced telephone systems such as Interactive Voice Response (IVR) systems allow riders to schedule trips, check scheduled ride times, confirm service, and cancel trips in an entirely automated system which does not require interaction with reservationists (Multisystems, 2002).

### Scheduling

The use of an automated scheduling system enables paratransit providers to generate each day's schedule by computer. Automated schedule development has become very sophisticated and can be adjusted to consider many factors such as individual customer needs, individual driver efficiency and traffic conditions at various times during the day (Multisystems 2002). However, due to that fact that the generated schedules are based on parameters set by the transit operator it is critical that the daily schedule be reviewed by employees to verify the process (Goodwill and Carapella, 2008). Review of the generated daily schedules also provides transit operators with ability to tweak the parameters of the automated scheduling system to provide a more efficient overall scheduling system.

Batch scheduling is a process whereby trips are scheduled after some of all reservations have been received. This type of scheduling system necessitates the ability to provide follow-

up contact with passengers in order to inform them of their scheduled pick-up time. This type of system has the ability to link Interactive Voice Response technology used for the reservation process to the scheduling system which allows for thousands of callbacks to be made to customers in order to convey their exact pick-up time (Multisystems, 2002).

### Dispatching

The two main technologies utilized in dispatching systems are Automatic Vehicle Location (AVL) and Mobile Data Terminal (MDT) systems. AVL systems enable dispatchers to know the exact location of all paratransit vehicles in service through the use of Global Positioning System (GPS) devices installed in the vehicles. The use of AVL technology permits more efficient oversight and improves responses to required rescheduling due to unforeseen interruptions to scheduled service.

With AVL technology in place, the use of Mobile Data Terminal (MDT) systems is enabled. MDTs provide the operators with paperless or electronic manifests (usually of the next four trips), allow the operators to record pick-up and delivery times and locations with a touch of a button, keep logs of times and mileage, and allow automated record keeping (Goodwill and Carapella, 2008). This technology also enables dispatchers to add, delete, or reassign trips in response to unforeseen interruptions in service as well as providing documentation of no-shows and the ability to provide mapping capabilities to aid vehicle operators in finding destinations.

### Autonomous Dial-A-Ride Technology

Autonomous Dial-A-Ride Technology (ADART) is a computerized, fully automated demand responsive paratransit system that operates without any centralized command and control (Dial and Ghani, 2003). The software fully automates all of the components of conventional paratransit systems including reservations, scheduling, dispatching, routing, and reporting and all dispatch and fleet management decisions are made by computers on board the vehicles in service. As described by Volpe Center analysts, ADART works as follows:

“Registered users simply call the on-board vehicle computer and enter their location and destination via a touch-tone keypad; the ADART system then develops an itinerary

and states a pick-up and destination arrival time. When the vehicle reaches that point in the itinerary, the on-board computer displays the address and directions for quick reference by the driver. Because new users must identify a payment method when they register, there is no need for on-board fare collection (Dial, 1995).”

ADART utilizes a number of technologies in an integrated manner. These technologies include AVL, automated routing and scheduling, geo-spatial technologies, wireless communications, vehicle navigation, and e-card technology. Other features of the ADART system that differentiates it from regular paratransit services include the following:

- ADART guarantees same-day service to its customers up to two hours in advance of the scheduled trip.
- ADART is adaptable and flexible to demand. Service can be initiated with only a few vehicles.
- The computer calls customers five minutes in advance to notify them that a vehicle is arriving. Customers are guaranteed a trip. The computer dispatches a taxicab if no ADART vehicles are available to satisfy a trip request.
- ADART’s on-vehicle routing software provides the driver an online map with directives on routes and passenger trip information, and estimated time of arrival at the next stop.
- All ADART trips are prepaid.

Autonomous Dial-A-Ride Transit (ADART) began operating in Corpus Christi, TX, in late 2003 and according to the Volpe Center although many technological elements of the project worked well, the needs of users were not completely addressed by the optimization algorithm used for paratransit operations, and therefore, community acceptance has not been as strong as desired (Research and Innovative Technology Administration, 2009).

## **3.0 Case Studies of Operators on the Central Coast of California**

### **3.1 Overview**

This part of the project examined case studies of demand response transit (DRT) operators in the Central Coast region of California, which includes places within and outside of San Luis Obispo (SLO) County. The techniques used were field investigations and personal interviews. This part of the study began with a development of interview questions and research of agencies to study. It was ideal to choose transit agencies that differed in size of operations, geographic coverage, types of DRT services offered and type of operator (i.e. private vs. public). The objective was to gather a range of responses to analyze how various transit operators could use a dispatch assistance tool. After interviews were compiled and examined, some commonalities and differences were made apparent and are reported in the Section 3.4 on Field Case Study and Interview Results. The results of the interviews and data from operations were used to examine performance measures. The following subsections present brief overviews of the interview questions and the agencies interviewed.

### **3.2 Interview Questions**

The interview questions were created based on a review of the literature and expected use of the information for purposes of this study. The literature review provided information on the different types and areas of demand response transit services, as well as a thorough analysis of Computer-Aided Scheduling and Dispatch (CASD) service components. The literature clearly revealed five categories of CASD software functions: reservations, scheduling, dispatching, routing and reporting. A key objective of the interviews therefore was to find out: (a) if the transit operator used a CASD system and, if so, (b) how it is used it with regard to the five functional categories, (c) what day-to-day or implementation problems they had, and (d) how it enhanced operations.

As stated in the introduction to this project, “the purpose of this study is to investigate and come up with a conceptual basis for an efficient system to aid Dial-A-Ride operations in

several areas including: (a) taking ride reservations, (b) assigning rides to vehicles, (c) optimizing vehicle routing, and (d) automatically generating reports which characterize system operation and ridership”. It is worth reiterating the fact that commercial CASD systems exist and are more readily afforded by large DRT operators; the dispatch assistance tool is to be developed to help the small to medium size operators. With this in mind, the interview questions were calibrated to retrieve information on how each operator took reservations, scheduled rides, routed vehicles, dispatched information, and reported data. Appendix 3-A is a sample of the structured guide to the interviews. Other quantitative data was also collected in order to analyze the performance of operations of each of the entities and to make conclusions as to the utilization of a CASD system for DRT operations.

### 3.3 Agencies Interviewed

In order to represent the range of demand responsive operators who may be classified as "small or medium", four different transit agencies were analyzed who were owned and operated by various public, private, and non-profit entities. The agencies differed in size of operations, population and geographic service coverage area. For example, one transit agency had only one vehicle and operated in one city, while another had 88 vehicles and operated throughout the whole county. These factors such as size and distance covered affected whether or not the agency felt it was necessary to obtain a CASD system and how the operator used the CASD system. Table 3-1 shows the different operators interviewed along with how many vehicles and dispatchers were used for daily operations.

Table 3-1: Summary of Demand Response Transit Operators Interviewed

| <b>DRT Operator</b> | <b>Number of Vehicles in Operation</b> | <b>Number of Dispatchers during Operation</b> |
|---------------------|--|---|
| Paso Robles Express | 1                                      | 1   |
| Ride-On             | 88                                     | 3   |
| RTA Runabout        | 13                                     | 2   |
| SMOOTH              | 20                                     | 1 to 2  |

### City of Paso Robles Dial-A-Ride

The Paso Robles Dial-A-Ride service is provided by the City's *Paso Express* transit agency, which also provides fixed route service. The Paso DRT is a curb-to-curb service that provides rides to the general public and stays within the city limits of Paso Robles. The Paso DRT is the smallest operation interviewed and only operates one designated DRT vehicle. Ridership generally consists of 40 percent seniors, 40 percent persons with disabilities, and 20 percent general public. The results of the interview can be seen in Appendix 3-B.

**Figure 3-1: Paso Express Bus**



Source: <http://www.pasoexpress.com/photos/index.htm>

### Ride-On, San Luis Obispo County

Ride-On is part non-profit and part for-profit demand response transit agency. Ride-On is the Consolidated Transportation Service Agency (CTSA) and a Transportation Management Association (TMA) for San Luis Obispo County. The services that Ride-On provides are the most diverse of all the DRT operators researched and interviewed for this study and throughout the region. Ride-On is the largest in terms of operations and rides provided, encompassing all unincorporated and incorporated areas of SLO County. The detailed interview results can be seen in Appendix 3-C.



**Figure 3-2: Ride-On Vehicle**



Source: <http://www.ride-on.org/>

DRT services provided by Ride-On include: (a) eligibility services in the form of door-to-door shuttles services for seniors, people with disabilities, and social service agencies in its capacity as a CTSA; and (b) general public services in the form of vanpools, special events charter, lunchtime express rides, guaranteed ride home, visitor shuttles, airport/Amtrak shuttles, and medical shuttles in its capacity as a TMA. Although Ride-On provides demand response transit, certain services have fixed schedules. The Vets Express is a service that is funded solely by fundraising and transports veterans on a fixed time schedule. Another semi-fixed service provided by Ride-On is the Five Cities Senior Shuttle which also has a fixed weekly time schedule but not a fixed route which still takes advanced ride reservations similar to that of a Dial-A-Ride service.

### **San Luis Obispo County Regional Transit Authority (RTA) & Runabout**

The San Luis Obispo County Regional Transit Authority (RTA) is a quasi-public transit agency that provides not only demand response services but also the fixed route bus service for the County of San Luis Obispo. Types of DRT services include: (a) Dial-A-Ride transit for the general public in various communities within the county and (b) Paratransit services for the elderly and disabled under the name, Runabout. Runabout is a Paratransit ADA complimentary service provided for ADA approved passengers anywhere in the county. RTA's Runabout service

operates approximately 13 vehicles and two dispatchers daily. Runabout is a relatively large operation as it covers the geographic region of San Luis Obispo County. According to the US Census, San Luis Obispo County had a 2010 population of 269,637 people. Runabout vehicles share vehicle storage and repair facilities with RTA's fixed route buses.

The DRT services charge fares and are specifically designated for the communities of Nipomo, Los Osos, Shandon & Paso Robles, and South County (which comprises five southern cities of SLO County – Arroyo Grande, Grover Beach, Pismo Beach, Shell Beach and Oceano). The DRT services are community specific and generally stay within the boundaries of the communities that they serve with the exception of the Shandon DRT that makes trips to Paso Robles. Dial-A-Ride service riders consist of seniors, low income, and youth.

**Figure 3-3: RTA Runabout Vehicle**



Source: <http://www.slorta.org/>

The interview for the RTA DRT was conducted at the RTA facility in San Luis Obispo with the Operations Manager. The details of this interview are included in Appendix 3-D.

**Santa Maria Organization of Transportation Helpers, Inc. (SMOOTH), Santa Maria**

The Santa Maria Organization of Transportation Helpers (SMOOTH) is a non-profit transportation service agency that provides both demand response transit services as well as

contracted fixed route services, and is the designated CTSA for the County of Santa Barbara. SMOOTH provides several DRT services which include a senior Dial-A-Ride for the Santa Maria/Orcutt area, Guadalupe Shuttle, Los Alamos Shuttle, and a Medical Van (DR 10). The Los Alamos Shuttle is semi-fixed route with typical destinations but still takes ride reservations and requests. The Medical Van provides rides three days a week for medical appointments from northern Santa Barbara County to the City of Santa Barbara.

Table 3-1 shows that SMOOTH has a slightly larger vehicle fleet than the RTA Runabout. SMOOTH provides a more diverse set of services than Runabout. Its largest rider segment consists of persons with disabilities. Appendix 3-E has additional details of the interview results.

### **3.4 Field Case Study and Interview Results**

Each interview was conducted at the offices of the operator and included operations managers and dispatchers. The following discussions summarize the findings from the interviews and make comparisons of transit operations in terms of the use of CASD system components. As presented in the previous section, all four of the transit agencies interviewed differed in size of vehicle fleet and geographic coverage, services provided, and type of agency (that is, whether public or private). These factors affected not only whether or not the transit operator used a CASD system, but also how it is used and satisfaction with its use. This section is organized by the five areas of CASD operation, but starts with a comparison of the use of a CASD system.

#### **Use of Computer-Aided Scheduling and Dispatch Systems**

Most of the operators interviewed used a Computer-Aided Scheduling and Dispatch (CASD) system to assist in reservations, scheduling, and routing. The two types of CASD software used are Trapeze and Route Match. Table 3-2 reveals that the only operator interviewed that did not use a CASD system was the Paso Robles DRT whose operation was significantly smaller than the others. All operators who had a CASD system used it for scheduling and routing; the RTA used it also for dispatching.

The only operator who had a mobile unit on each vehicle was RTA, which assisted in some dispatching duties, such as change in schedule and pick-up and drop-off information. The mobile unit significantly reduces the amount of data entry required for the dispatcher since most of the ride information is inserted into the computer by the driver as opposed to writing it first on paper to be typed later into a computer by the dispatcher. Ride-On anticipated the installation of GPS mobile units and expected that the technology would significantly reduce dispatcher communications with drivers.

Table 3-2: Comparative Use of Computer-Aided Scheduling and Dispatch (CASD) System

| <b>DRT Operator</b> | <b>Use of CASD System?</b> | <b>Type of System</b>                       | <b>Operations Using CASD</b>         |
|---------------------|----------------------------|---|--------------------------------------|
| RTA Runabout        | Yes                        | Trapeze (in process of getting Route Match) | Scheduling, Routing, and Dispatching |
| Ride-On             | Yes                        | Route Match TS 4.1.5                        | Scheduling & Routing                 |
| SMOOTH              | Yes                        | Trapeze (Novis)                             | Scheduling & Routing                 |
| Paso Robles         | No                         | N/A   | N/A                                  |

**Reservations**

All the four operators interviewed took reservations over the phone and then inserted the information into the computer. For operators with a CASD system, the rider’s name can be stored and for repeat customers the information can be retrieved to eliminate the repetition of data entry. This saves a significant amount of time, especially for those passengers who have to be verified for the service.

All of the operators have at least a 2 hour advance reservation requirement with a 1 week limitation; this holds true whether or not the operator has a CASD system. As shown in Table 3-3 some operators even have a maximum time frame of when reservations can be made, which in most cases is 1 week. Although there is a minimum time requirement, most operators say that they try to accommodate last minute calls as much as feasible. Table 3-3

indicates that there seems to be no relation between the use of a CASD system and reservation requirements. It is worth noting that the one operator who does not have a CASD system has only one vehicle; therefore the scheduling is not as complicated as the others with multiple vehicles. Having only one DRT vehicle enables Paso Express to accommodate reservations at short notice to a similar extent as those that have CASD systems but must manage multiple vehicles.

Every operator but one does not allow subscription services. There were two main reasons for not allowing subscription services: one is that if it was allowed then the DRT services would be booked weekly and would not have room for the general public and other users; another reason is that it would complicate scheduling. RTA did not explain why it allows subscription, but it could be explained by its charge to provide service to specific groups of prequalified patrons. There is no correlation between having a CASD system and providing subscription service.

Table 3-3: Reservation Comparisons

| <b>DRT Operator</b> | <b>Use of CASD system?</b> | <b>Information Entered into Computer?</b> | <b>Minimum and Maximum Reservation requirements</b>                  | <b>Subscription service allowed?</b> |
|---------------------|----------------------------|---|--|--------------------------------------|
| RTA Runabout        | Yes                        | Yes                                       | 2 hours min. (Dial-A-Ride)<br>24 hours min. & 1 week max. (Runabout) | Yes                                  |
| Ride-On             | Yes                        | Yes                                       | 2 hours min.   | No                                   |
| SMOOTH              | Yes                        | Yes                                       | 2 days to 1 week min.  | No                                   |
| Paso Robles         | No                         | Yes                                       | 2 hours min. & 1 week max.   | No                                   |

### Scheduling and Dispatching

Table 3-4 shows that operators with a CASD system in place schedule their rides in a dynamic fashion, while the operator without a CASD system allocates the schedule in 15 minute time blocks. In the interviews one operator was asked how scheduling was accomplished before the

CASD system. The response was that the agency allocated 15 minute time blocks. The RTA Runabout uses a CASD system and yet allocates 15-minute time blocks for the DRT services, but not the others.

Communication between drivers and dispatchers remained consistent amongst the different DRT operators. The following were the typical reasons why the dispatcher normally communicates with a driver: adjustments to schedule (for add-ons or cancelations), no-shows, and driver gets off schedule. The only operator whose dispatcher and driver communicate at every pick-up and drop-off was the Paso Robles DRT, which is also the only operator that did not have a CASD system in place, therefore constantly having to communicate. In addition, RTA has on-board mobile units in the vehicles, which significantly reduces the communication required between the dispatcher and driver.

None of the operators have automated phone systems that contact riders prior to ride pick-up or to confirm ride reservations. Both Ride-On and SMOOTH contact riders if they do not show within 2 minutes of vehicle arrival. To accomplish this, the driver first informs dispatch and then dispatch contacts the rider. All operators wait on a rider for about 2 to 3 minutes before proceeding.

Table 3-4: Scheduling and Dispatching Comparisons

| <b>DRT Operator</b> | <b>Use of CASD System?</b> | <b>How Rides are Scheduled</b>                         | <b>Items of Operator &amp; Dispatch Communication</b>                               |
|---------------------|----------------------------|--|---|
| RTA Runabout        | Yes                        | Dynamic (Runabout) 15 minute time blocks (Dial-A-Ride) | For adjustments to schedule, driver breaks, or problems (e.g. no-shows)             |
| Ride-On             | Yes                        | Dynamic  | For no-shows, add-ons, or cancelations  |
| SMOOTH              | Yes                        | Dynamic  | When late or early for pick-up or drop-off; and for no-shows and change of schedule |
| Paso Robles         | No                         | 15 minute time blocks                                  | At pick-up and Drop-off   |

The complexities or issues with scheduling and routing between agencies differed mostly based on size of operations and services provided. In three of the interviews conducted, dispatchers were questioned in face-to-face settings. Various responses were given concerning dispatcher satisfaction with or use of the CASD system. For Ride-On, whose services are the most diverse and complex, the CASD system did not seem to meet the dispatcher needs very well, as it took three dispatchers who were constantly communicating with drivers and updating and adjusting the schedules and routes. Ride-On was also in the process of purchasing mobile GPS units for each vehicle, in which the dispatchers seemed hopeful that the units would reduce communications with drivers and increase real-time information for more efficient scheduling and route matching. A dispatcher at RTA seemed satisfied with the CASD system in place (Trapeze) and felt that it was relatively efficient. Regardless of the level of dispatcher satisfaction with the CASD system, all dispatchers at some point stated that scheduling and routing required constant adjustments as the CASD systems were not completely accurate.

### **Routing**

For routing, operators were asked to indicate which routines they typically adhered to from a list of the following three options: (a) 1<sup>st</sup> pick-up/ 1<sup>st</sup> drop-off; (2) sequential pick-up/ nearest drop-off; or (c) pick-up/drop off prioritized by scheduled arrival time. Table 3-5 shows that all of the operators route vehicles according to the sequential pick-up/nearest drop-off routine regardless of whether the agency had a CASD system or not. One operator (RTA) mixed it up with the additional routine of prioritizing by scheduled arrival time depending on how the computer chose routes and how dispatchers adjusted the routes.

### **Reporting**

Reporting practices were straight forward. Operators stored rider information on paper or electronically or stored it in a combination of both media. The three operators with a CASD system input and stored most of the data electronically. Operators with a CASD system with mobile units could fully input all data electronically and did not have to rely on paper reporting. The operators with a CASD system with no mobile units still had to input daily operations data

gathered from the drivers that day into the computer. The operator without a CASD system reported and stored all data on paper.

Table 3-5: Routing Comparisons

| <b>DRT Operators</b> | <b>Use of CASD System?</b> | <b>Vehicle Routing</b>   |
|----------------------|----------------------------|--|
| RTA Runabout         | Yes                        | Sequential pick-up/nearest drop-off<br>Pick-up/prioritized by scheduled arrival time           |
| Ride-On              | Yes                        | Sequential pick-up/ nearest drop off   |
| SMOOTH               | Yes                        | sequential pick-up/ nearest drop off<br>(as long as scheduled arrival times fit into schedule) |
| Paso Robles          | No                         | Sequential pick-up/ nearest drop off (as long as scheduled arrival times fit schedule)         |

### 3.5 Observations

Certain general observations become apparent from looking at the different interview results and making comparisons between those operators who use a CASD system and those who do not. Three of the four case studies utilized some sort of a CASD system. The one operator who did not use a CASD system offered one type of service (non-prescription, public DRT) using only one vehicle for that service. This means that this may not be typical of other DRT operators in rural areas who do not have a CASD system and have a larger and more disperse population to serve with different services. Therefore, comparisons between the operators in this case study may not be representative of all situations.

It seemed as though the operators with a CASD system were more able to manage ride requests, match the rides to a driver and route, and store daily operations information. Although each operator did things a little differently and calibrated the CASD system the best way they could to work for their particular services and coverage areas, all of the three operators with a CASD system still had to adjust the schedule and routes throughout the day as



things changed. All CASD system users expressed some frustration with the programs. This suggests that there is room for improvement in designing a CASD system that is specifically calibrated for DRT operations.

## **3.6 Analysis**

### **Performance Measures**

Operations data was collected and analyzed for SMOOTH senior DRT, Paso Robles public Dial-A-Ride, and RTA ADA paratransit services. The three examples represent variations in the target groups for services provided. Paso Robles DRT provides the most complete public service. SMOOTH is semi-public, but for all seniors. RTA paratransit is the most restricted requiring pre-qualification. The information obtained was converted into monthly data for comparison purposes and represents an average month for the fiscal year 2008/09 (July 2008 to June 2009). Standard performance measures that are applied in the industry are used for the assessment. They include fare box recovery ratio, operating cost per rider, operating cost per vehicle service mile (VSM), and operating cost per vehicle service hour (VSH).

Table 3-6 summarizes the operating costs and performance measures among the agencies. SMOOTH delivered slightly larger hours and miles of service, but incurred a significantly lower total operating cost than Paso Robles DRT. These costs and services translated therefore into lower unit costs per service hour or mile for SMOOTH than Paso Robles DRT. This could be partially explained by the fact that SMOOTH service is handled by a private operator while Paso Robles DRT is a public operation. It could also be partially explained by the nature of the services provided. Since SMOOTH service was for seniors, activity destinations and scheduling were more predictable than serving variable travel needs of the general public as Paso Robles DRT faced. Yet the ability to serve the general public translated into higher ridership per vehicle hour at Paso Robles DRT than SMOOTH making for only a small difference in operating costs per rider. RTA's paratransit service had the advantages of serving a large geographical area with the aid of a CASD system, which translated into the lowest cost per

service mile among the three agencies; it has a disadvantage in serving a restricted segment of the population, which resulted in the highest cost per service hour and operating cost per rider.

SMOOTH (at \$3.67) and RTA (at \$2.86) performed significantly better in operating costs per VSM than Paso Robles DRT (at \$6.76). This may mean that the computer aided software significantly improves vehicle routing, which boosted the number of shared trips and therefore reduced the amount of extra or single trip miles driven.

The fare box recovery ratios (that is, the ratio of revenues to operating costs) revealed that Paso Robles DRT had the lowest ratio of 5.6 percent, while SMOOTH (10.5%) and RTA (7.3%) attain slightly higher ratios. The ratio is a function of scale of operations and patronage. Larger scale operations can share fixed costs over several more units than smaller scale operations. And higher patronage can result in higher revenues.

Table 3-6: Summary of Measures of Performance

| <b>Performance Measure</b>      | <b>SMOOTH</b>  | <b>Paso DAR</b> | <b>RTA</b> |
|---------------------------------|----------------|-----------------|------------|
| <i>Target Group of Service</i>  | <i>seniors</i> | <i>public</i>   | <i>ADA</i> |
| Ridership                       | 591            | 653             | 2,487      |
| Vehicle Service Hours (VSH)     | 377            | 332             | 1,274      |
| Vehicle Service Miles (VSM)     | 4,115          | 3,344           | 31,911     |
| Revenues                        | \$1,444        | \$1,267         | \$1,268    |
| Fare Box Recovery Ratio         | 10.49%         | 5.60%           | 7.27%      |
| Operating Cost                  | \$13,950       | \$22,605        | \$22,605   |
| <i>Operating Cost per VSH</i>   | \$34.19        | \$68.17         | \$68.17    |
| <i>Operating Cost per VSM</i>   | \$3.67         | \$6.76          | \$2.86     |
| <i>Operating Cost per Rider</i> | \$26.47        | \$29.81         | \$29.81    |
| <i>passengers per VSH</i>       | 1.57           | 1.97            | 1.95       |

## Conclusions

While the number of cases examined was not intended to be a representative sample of DRT operators, this close examination nevertheless provided certain insights for the conduct of the remainder of the study. From the foregoing findings, it can be concluded that DRT operators that utilize some sort of CASD system can show a significant reduction in operating cost per

VSM as it can improve vehicle routing, which would boost the number of shared trips and reduce the amount of extra or single trip miles. It is apparent that serving the public at large is beneficial as it would widen the pool of potential riders for a given amount of vehicle service hours. Serving a relatively large geographic area is closely related to widening the pool of potential riders. However, there is a limit beyond which the geographical extent can result in diminishing returns when unit vehicle service miles begin to rise. Using this primer of limited case examinations, reported Dial-A-Ride data was examined for selected additional operators by size and cost of operations within the state of California.

## 4.0 Identification of Efficient Operators

### 4.1 Overview

This section compares performance measures of Demand Response Transit (DRT) operators in California using 2008 data obtained from the National Transit Database (NTD). Two sets of comparisons of performance measures are presented. One set compares performances of Demand Response Transit (DRT) and fixed-route bus transit (FBT) in general. The second set compares the DRT to FBT in terms of agency size. Data for 72 DRT agencies and 89 FBT agencies within the State of California were compiled for 2008 in order to calculate the performance measures. The analysis examined three NTD-recommended key performance measures as follows:

- Passenger trips per revenue vehicle hour (Passenger Trips/ Revenue Vehicle Hours)
- Operating cost per revenue vehicle hour (Operating Expenses/ Revenue Vehicle Hours)
- Operating cost per passenger trip (Operating Expenses/ Total Passenger Trips)

### 4.2 Purpose

The comparisons are made to discern if there are substantial differences or overlaps in unit performance measures between fixed route and DRT services. If overlaps exist, the results would support a hypothesis that there is room to improve DRT operations to match the performance level of fixed-route public transit. Results would also help identify agencies that realize the most efficient performances from which to investigate underlying factors.

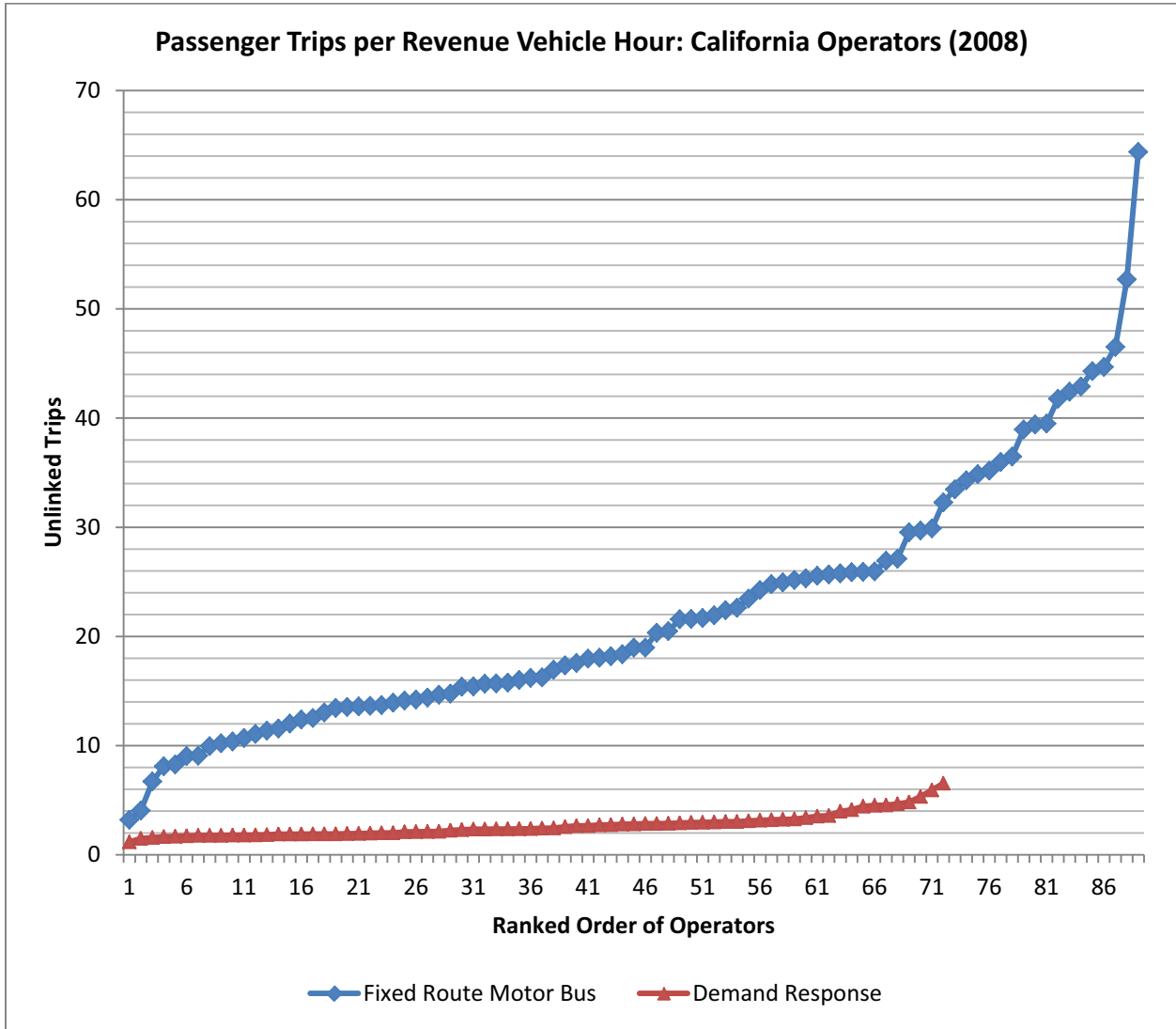
### 4.3 Overall Comparison of Performance Measures

#### Passenger Trips per Revenue Hour

The metric, passenger trips per revenue vehicle hour, provides a measurement of the productivity of the public transportation system and is widely considered the single most

important performance measure in assessing a system’s effectiveness. As a performance measure, productivity captures the ability of the DRT system to schedule and serve passenger trips with similar origins, destinations, and time parameters, using the least number of in-service vehicles and revenue hours (TCRP Report 124, 2008). Figure 4-1 shows the distributions of passenger trips per revenue vehicle hour for the DRT and the FBT operations examined.

**Figure 4-1: Comparative Distributions of Passenger Trips per Revenue Hour**



The data shows that the majority (71%) of fixed-route transit bus operations for which data was available within California achieved levels of productivity of between 10 and 30 passenger trips per revenue vehicle hour. A good proportion (20%) achieved higher productivity and a small proportion (9%) achieved lower productivity. Comparatively, a simple majority

(58%) of DRT operators achieved levels of productivity between 2 and 4 passenger trips per revenue vehicle hour. A small proportion (11%) achieved higher productivities (up to 6 passenger trips per hour) while a substantial proportion (31%) achieved lower productivities (down to 1 passenger trip per hour). Results demonstrate that in general the productivity of DRT is lower than that of fixed-route bus systems and reaffirms the notion of previous studies that fixed route bus services tend to be more productive than DRT services. The results should not be surprising. Fixed-route bus transit operations are typically established in corridors where there are accumulations of demand for travel. DRT services, in contrast, tend to serve desire lines of travel for which there were not sufficient accumulation of demand to warrant the establishment of fixed-route service.

The analysis revealed a range of overlap between the low productivity range of fixed-route bus services (3 to 6 trips per hour) and the high productivity range of DRT services. A good proportion (28%) of the DRT operations fell within this overlap region. These operators were noted for potential further evaluation. The argument can be made that if there is justification to maintain the lower productivity fixed-route services then similar justification could be made for DRT services with similar levels of productivity.

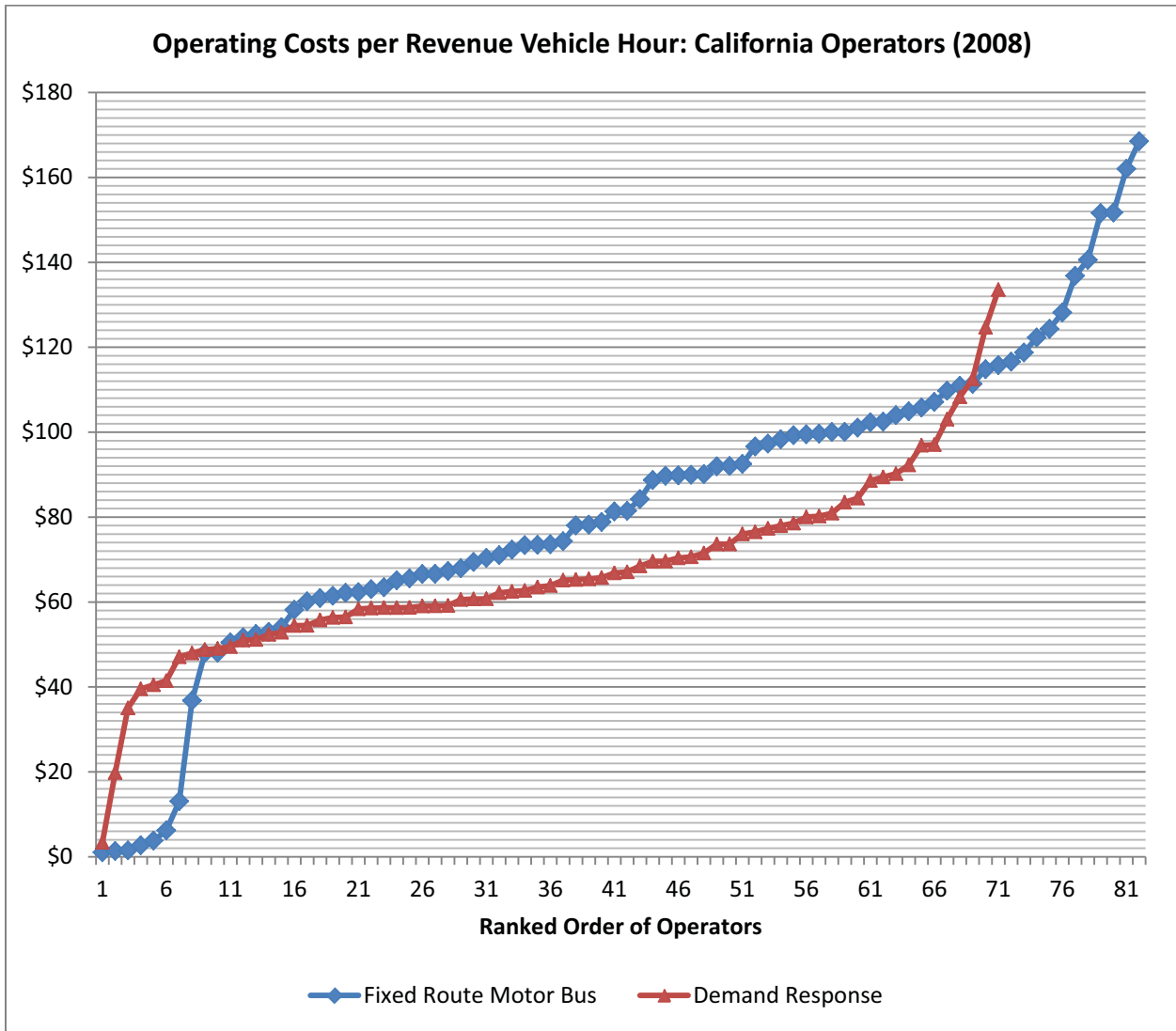
### **Operating Cost per Revenue Vehicle Hour**

Operating cost per revenue vehicle hour is considered to be the key cost-efficiency measure in that it establishes the financial resources needed to produce an hour of revenue service. The total operating costs for the agencies studied include the following cost categories:

- Vehicle operations
- Vehicle maintenance
- Non-Vehicle maintenance
- General administration

Figure 4-2 shows the breakdown of operating cost per revenue vehicle hour for the DRT and the fixed-route bus operations that were examined.

**Figure 4-2: Comparative Distributions of Operating Costs per Revenue Vehicle Hour**



The data shows that nearly two-thirds (64%) of fixed-route transit bus operations within California achieved levels of cost efficiency between \$50 and \$110 per revenue vehicle hour. One quarter (25%) achieved lower cost efficiencies (that is, higher cost per hour) and a small proportion (11%) achieved higher cost efficiencies (or lower cost per hour). Comparatively, nearly four out of five (79%) of DRT operators achieved levels of cost efficiency between \$50 and \$110 per revenue vehicle hour. A small proportion (6%) achieved lower cost efficiencies while a noticeable proportion (15%) achieved higher cost efficiencies (or lower hourly cost). Results demonstrate that in general the cost efficiency of DRT operations is better than that of fixed-route bus systems, but similarities are abundant. The results can be explained. Fixed-

route bus transit operations typically use large vehicles that are more expensive to operate in terms of fuel and are constantly in service. DRT services, in contrast, tend to use smaller vehicles that do not have to run always unless there is demand to serve passengers.

The analysis revealed a range of very wide overlap in cost efficiency between fixed-route bus services and DRT services in general. The majority (79%) of the DRT operations fell within the typical range of costs per revenue vehicle hour for fixed-route operations. The DRT operators within the typical range and lower were noted for potential further evaluation.

### **Operating Cost per Passenger Trip**

The third performance measure used in the comparison of DRT and FBT services within California is operating cost per passenger trip. This performance measure combines elements of the first two measures — operating cost per revenue hour and passenger trips per revenue hour — relating productivity to cost efficiency. This third performance measure is of particular importance because in the two prior performance measures an agency with a high operating cost per revenue vehicle hour could still have a low operating cost per passenger trip if the productivity of that agency is particularly high and vice-versa.

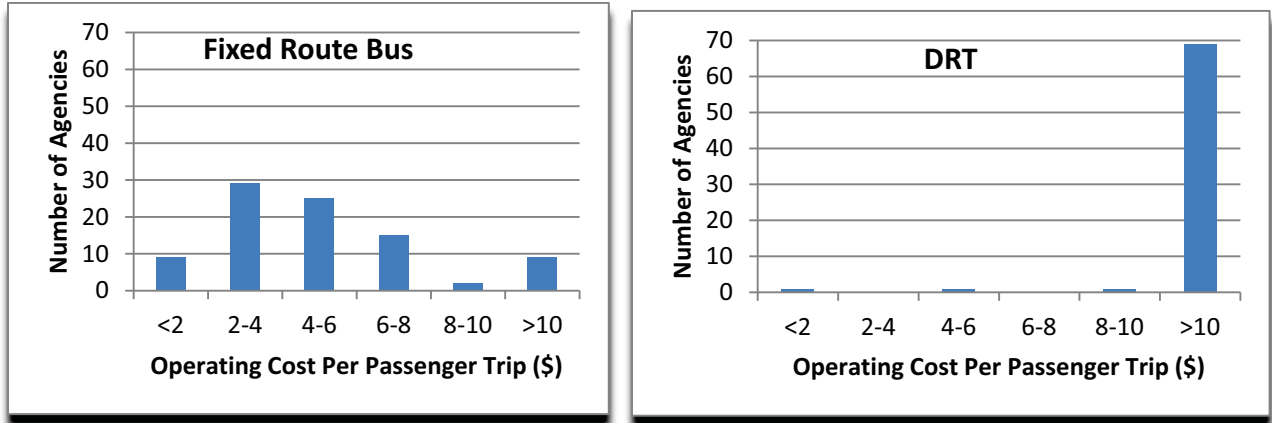
Figure 4-3a shows the distribution of operating cost per passenger trip for the DRT and the FBT operations that were examined. The difference between the two types of agencies is most dramatic for this performance measure. Results reveal that the typical range of operating costs per passenger trips for FBT operations was between \$2 and \$6 for 62 percent of operators examined. A few (10%) even achieved lower costs while a notable proportion (28%) reported higher costs per passenger.

In contrast, 96 percent of DRT operations examined reported operating costs over \$10 per passenger trip. This demonstrates that while a substantial number of DRT operations were able to succeed in either providing comparable numbers of passenger trips per revenue hour or in operating at a comparable cost per revenue hour, rarely did any of the DRT agencies within California successfully provide service that integrated the two performance measures. Figure 4-3b shows that the typical range for DRT operations is between \$15 and \$40 per passenger trip,

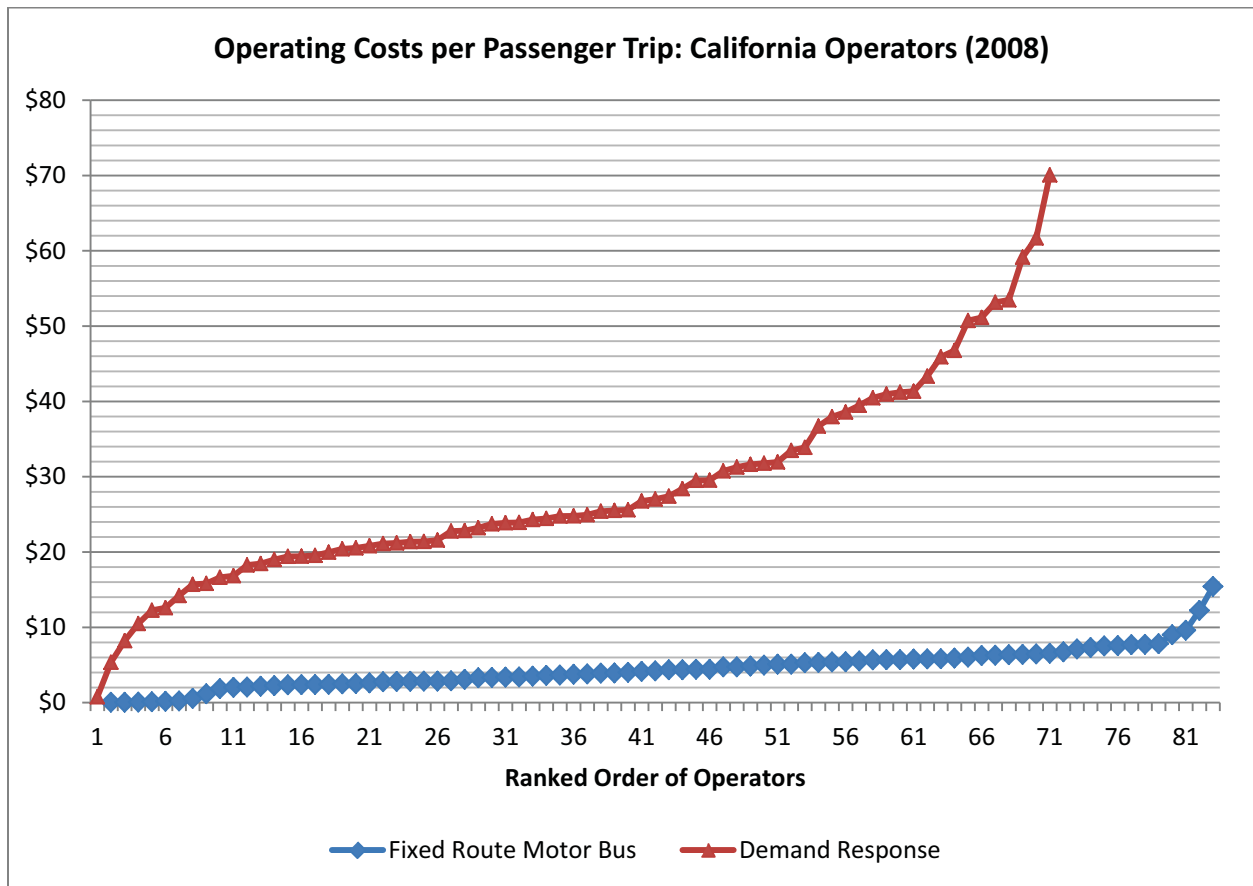


which is four to ten times the normal range for FBT operations. There is, a range of overlap between the high end of FBT and the low end of DRT that is worthy of further examination.

**Figure 4-3a: Comparative Distributions of Operating Costs per Passenger Trip**



**Figure 4-3b: Comparative Ranges of Operating Costs per Passenger Trip**



## 4.4 Comparison of Performance Measures by Agency Size

To compare agencies based on their size the data was organized into four major groups of DRT systems and analyzed in terms of the three different performance measures discussed in the previous subsections. The agency size classifications were based on the amount of service supplied by operators, measured in annual vehicle miles. The levels of service supplied placed each operation into one of four size categories based on the deviation from the sample mean of vehicle miles operated. Table 4-1 shows the sizes, breakpoints and distribution of operators by size. Agency sizes of operators form a broad-based pyramid. The majority of operators fall under the "smallest" size classification among both FBT and DRT operators, followed by those classified as "small", then those classified as "large" and those classified as "largest".

Table 4-1: Classification of Operators by Size of Service Supplied

| Agency Size                    | Range of Annual Vehicle Miles (VMT) Produced (1,000s) | Range of Deviations from Mean VMT | Percent of Operators |
|--------------------------------|---|-----------------------------------|----------------------|
| <b>Fixed-Route Bus Transit</b> |   |                                   |                      |
| Smallest                       | 5 to 56   | -0.4 to -0.1                      | 61%                  |
| Small                          | 60 to 131   | -0.1 to 0.1                       | 19%                  |
| Large                          | 165 to 315  | +0.1 to +1.0                      | 15%                  |
| Largest                        | 511 to 2460   | +1.0 to +8.3                      | 6%                   |
| <b>Demand Response Transit</b> |   |                                   |                      |
| Smallest                       | 9.8 to 550  | -0.4 to -0.1                      | 64%                  |
| Small                          | 595 to 1548   | -0.1 to 0.1                       | 18%                  |
| Large                          | 1649 to 4438  | +0.1 to +1.0                      | 13%                  |
| Largest                        | 7035 to 33590   | +1.0 to +7.3                      | 6%                   |

### Passenger Trips per Revenue Vehicle Hour by Agency Size

Figure 4-4 shows that FBT systems depict wide ranges of productivity levels by agency size. DRT systems depict much lower ranges of productivity, but all tend exhibit rather low levels. It is notable that variability in productivity is generally wider for smaller sized DRT agencies as small and smallest DRT operations, for instance, exhibit the greatest range of passenger trips per revenue vehicle hour. DRT operations registered an overall average of approximately 3 passenger trips per revenue vehicle hour. In addition to a wide variability in productivity in all size categories, FBT systems also depict a general decline in level of productivity as agency size

declines. Overall, FBT operations registered an average of 22 passenger trips per revenue vehicle hour. In order to better understand the factors that contributed to the agencies that achieved greater degrees of performance in this regard the most productive agencies were selected for potential further study through interviews.

**Figure 4-4: Comparative Distributions of Passenger Trips per Revenue Hour by Agency Size**

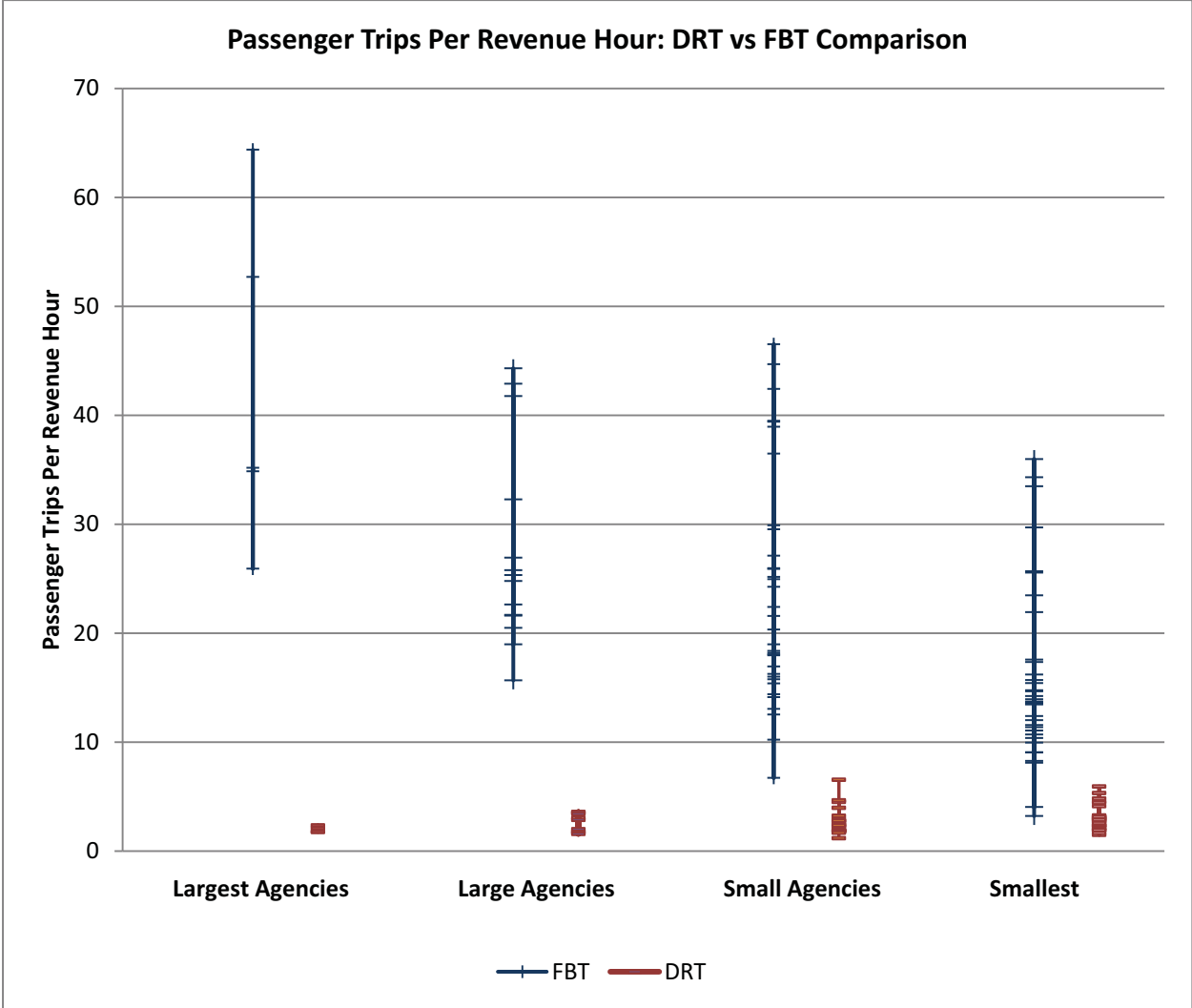


Table 4-2 shows the top fifteen performing agencies (in rank order of performance) for potential further study. All sizes are represented except for the largest.

Table 4-2: Top Performing DRT Operators for Passenger Trips per Hour

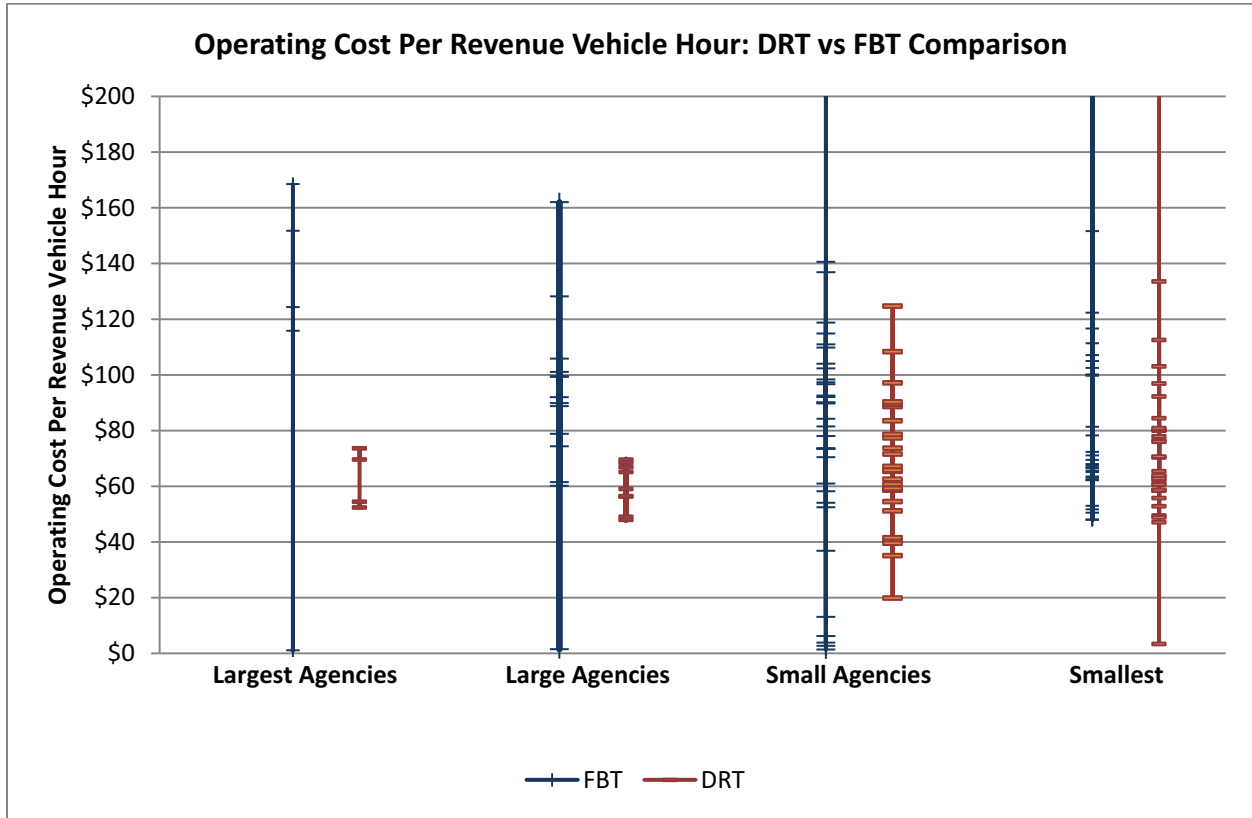
| <b>DRT Agency</b>  | <b>Size</b> | <b>Rank</b> |
|--|-------------|-------------|
| Ventura Intercity Service Transit Authority (VISTA)                                  | Smallest    | 1           |
| Montebello Bus Lines (MBL)   | Smallest    | 2           |
| Norwalk Transit System (NTS)   | Smallest    | 3           |
| Long Beach Transit (LBT)   | Smallest    | 4           |
| Torrance Transit System (TTS)  | Smallest    | 5           |
| City of Arcadia Transit (Arcadia Transit)  | Smallest    | 6           |
| City of Riverside Special Transportation (City of Riverside)                         | Small       | 7           |
| Norwalk Transit System (NTS)   | Smallest    | 8           |
| City of Corona (CCTS)  | Smallest    | 9           |
| Merced County Transit (The Bus)  | Small       | 10          |
| City of Los Angeles Department of Transportation (LADOT)                             | Large       | 11          |
| LACMTA - Small Operators (LACMTA)  | Large       | 12          |
| San Francisco Municipal Railway (MUNI)   | Large       | 13          |
| County of Sacramento Municipal Services Agency Department of Transportation (SacDOT) | Smallest    | 14          |
| Yuba-Sutter Transit Authority (YSTA)   | Smallest    | 15          |

### Operating Cost per Revenue Vehicle Hour by Agency Size

Figure 4-5 shows operating costs per revenue vehicle hour and indicates wide viability in performance for both DRT and FBT operations. DRT operations average \$67 per revenue vehicle hour, while FBT operations average \$81 per revenue vehicle hour. This is the one performance measure for which DRT is highly competitive against fixed-route bus.

In order to gain a better understanding of the operating practices of DRT agencies that were able to keep their operating costs low the top performing agencies were selected for further consideration. Table 4-3 identifies them in rank order of performance by agency size. All size categories are represented, including a sole agency in the "largest" size category.

**Figure 4-5: Comparative Distributions of Operating Costs per Revenue Hour by Agency Size**



**Table 4-3: Top Performing DRT Operators for Cost per Revenue Vehicle Hour**

| <b>DRT Agency</b>                                   | <b>Size</b> | <b>Rank</b> |
|---|-------------|-------------|
| Norwalk Transit System (NTS)                        | Smallest    | 1           |
| Santa Barbara Metropolitan Transit District (SBMTD) | Smallest    | 2           |
| Ventura Intercity Service Transit Authority (VISTA) | Smallest    | 3           |
| Thousand Oaks Transit (TOT)                         | Smallest    | 4           |
| Monterey-Salinas Transit (MST)                      | Small       | 5           |
| Golden Empire Transit District (GET)                | Smallest    | 6           |
| Placer County Department of Public Works (PCDPW)    | Smallest    | 7           |
| San Diego Metropolitan Transit System (MTS)         | Large       | 8           |
| Montebello Bus Lines (MBL)                          | Smallest    | 9           |
| Riverside Transit Agency (RTA)                      | Large       | 10          |
| City of Santa Rosa (Santa Rosa CityBus)             | Smallest    | 11          |
| Fresno Area Express (FAX)                           | Small       | 12          |
| Gold Coast Transit (GCT)                            | Small       | 13          |
| Orange County Transportation Authority (OCTA)       | Largest     | 14          |
| City of Gardena Transportation Department (GMBL)    | Smallest    | 15          |

### Operating Cost per Passenger Trip by Agency Size

Figure 4-6 shows operating cost per passenger trip, which is considered the most effective performance measure for gauging overall performance due to the fact that it combines the previous two performance measures into one. This allows for the identification of the agencies that have accomplished the balancing of operating costs and productivity of their systems to provide the most cost effective DRT systems. Similar to what is shown in the prior comparisons the greatest variation in the operating cost per passenger trip occurs among the small and smallest agencies. FBT operations averaged operating costs of \$8.75 per passenger trip while DRT operations averaged \$28 per passenger trip.

**Figure 4-6: Comparative Operating Costs per Passenger Trip by Agency Size**

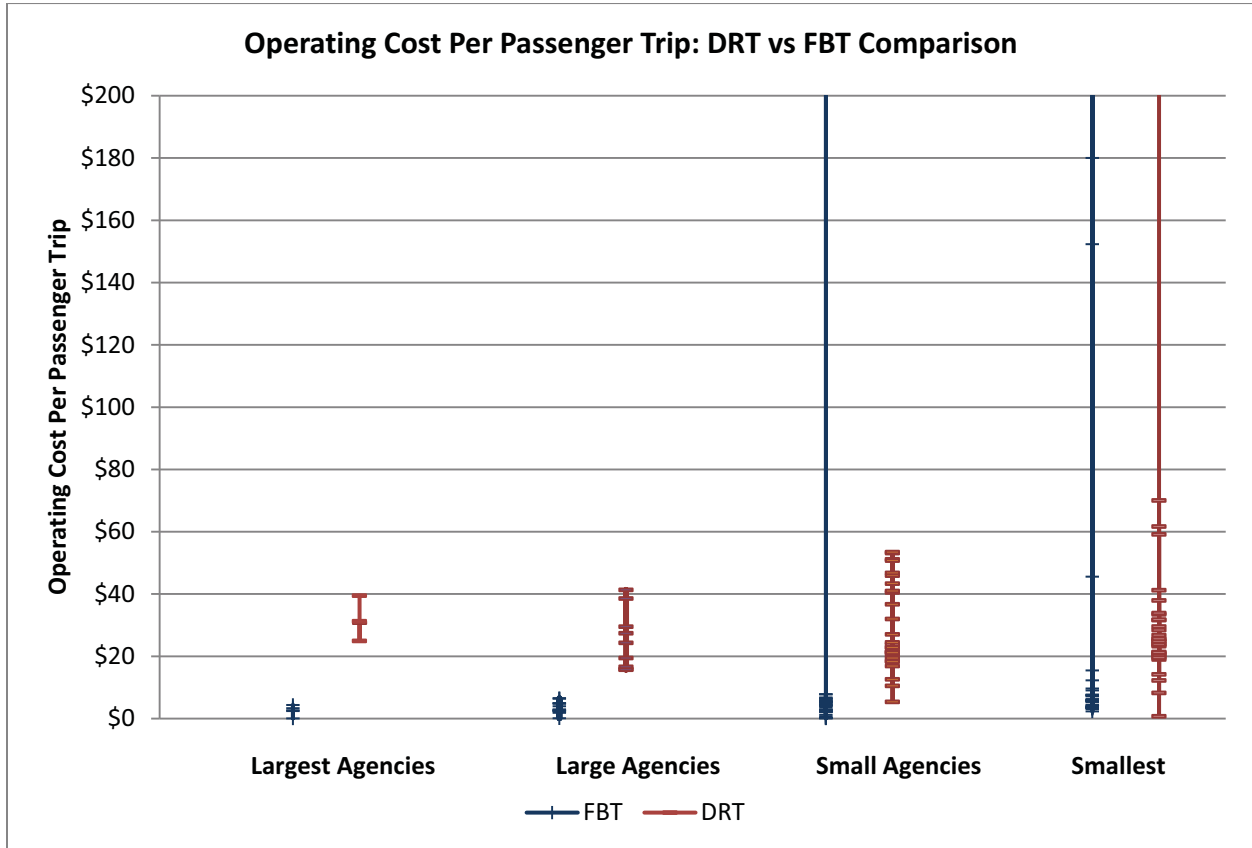


Table 4-4 shows the top DRT performers in terms of cost per passenger trip. All sizes are represented except for the largest and the "small" size has only one agency.

Table 4-4: Top Performing DRT Operators for Cost per Passenger Trip

| <b>DRT Agency</b>  | <b>Size</b> | <b>Rank</b> |
|--|-------------|-------------|
| Norwalk Transit System (NTS)   | Smallest    | 1           |
| Ventura Intercity Service Transit Authority (VISTA)                                  | Smallest    | 2           |
| Montebello Bus Lines (MBL)   | Smallest    | 3           |
| Santa Barbara Metropolitan Transit District (SBMTD)                                  | Smallest    | 4           |
| City of Arcadia Transit (Arcadia Transit)  | Smallest    | 5           |
| Torrance Transit System (TTS)  | Smallest    | 6           |
| City of Corona (CCTS)  | Smallest    | 7           |
| City of Los Angeles Department of Transportation (LADOT)                             | Large       | 8           |
| San Diego Metropolitan Transit System (MTS)  | Large       | 9           |
| San Francisco Municipal Railway (MUNI)   | Large       | 10          |
| Thousand Oaks Transit (TOT)  | Smallest    | 11          |
| Yuba-Sutter Transit Authority (YSTA)   | Smallest    | 12          |
| City of Riverside Special Transportation (City of Riverside)                         | Small       | 13          |
| County of Sacramento Municipal Services Agency Department of Transportation (SacDOT) | Smallest    | 14          |
| LACMTA - Small Operators (LACMTA)  | Large       | 15          |

### Consistent Top Performers for Further Survey

Agencies that performed consistently well according to the three performance measures formed the pool contacted for further study. The following three agencies performed well in terms of all three measures, but they were all in the smallest size category:

1. Norwalk Transit System (NTS) -- Smallest
2. Ventura Intercity Service Transit Authority (VISTA) -- Smallest
3. Montebello Bus Lines (MBL) -- Smallest

Seven agencies appeared among top performers in two out of three measures of which Los Angeles County and San Diego were in the "large" size category and City of Riverside was in the "small" category. Only Orange County appeared in the "largest" size category.

## 5.0 Selected Efficient Operators

### 5.1 Agencies Interviewed

Five different transit agencies responded to interviews from the pool of top performers. Most were adjudged model services based on high attainment in one or all of the performance measures discussed in the previous section. Table 5-1 shows the agencies interviewed and their respective sizes.

Table 5-1: DRT Operators Selected for Further Study

| <b>DRT Operator</b>   | <b>Size Classification</b> |
|---|----------------------------|
| Los Angeles - Access Services Incorporated (ASI)  | Largest                    |
| Orange County Transportation Authority(OCTA) ACCESS   | Largest                    |
| Fresno Area Express (FAX)   | Small                      |
| Fillmore Area Transportation Corporation of The Ventura Intercity Service Transit Authority (VISTA) | Smallest                   |
| Norwalk Transit System  | Smallest                   |

The number of vehicles operated as well as dispatchers employed varied among all of the selected agencies. Table 5-2 provides a breakdown of vehicular and manpower resources used by the agencies.

Table 5-2: Available DRT Resources for Selected Operators

| <b>DRT Operator</b>   | <b>Number of Vehicles in Operation (Daily)</b> | <b>Number of Dispatchers Employed</b> |
|---|--|---------------------------------------|
| Los Angeles - Access Services Incorporated (ASI)  | 400-500  | 15-20                                 |
| Orange County Transportation Authority(OCTA): ACCESS  | 248  | 15                                    |
| Fresno Area Express (FAX)   | 44   | 4                                     |
| Fillmore Area Transportation Corporation of The Ventura Intercity Service Transit Authority (VISTA) | 13   | 2                                     |
| Norwalk Transit System  | 5  | 2                                     |



### **Los Angeles County Access Services**

Access Services is the local public entity that administers the Los Angeles County Coordinated Paratransit Plan for the County's 43 public fixed route operators. Access Paratransit service is available for any ADA paratransit eligible individual for any purpose and to or from any location within a  $\frac{3}{4}$  mile of any fixed route bus operated by the Los Angeles County public fixed route bus operators and within a  $\frac{3}{4}$  mile around METRO Rail stations during the hours that the systems are operational. The service area is divided into regions and extends into portions of the surrounding counties of San Bernardino, Orange and Ventura that are served by Los Angeles County Fixed-route bus lines. Effectively, the DRT service serves the function of "feeder" to fixed-route transit, but it is restricted to qualifying patrons.

### **Orange County Transportation Authority**

The Orange County Transportation Authority (OCTA) operates ACCESS which is OCTA's shared-ride service for people who are unable to use the regular, fixed-route bus service because of functional limitations caused by a disability. These passengers must be certified by OCTA to use the ACCESS system by meeting the Americans with Disabilities Act (ADA) eligibility criteria. ACCESS offers a combination of standard, door-to-door, subscription, and same day taxi service. OCTA-ACCESS is thus restricted to qualifying patrons for complete origin to destination (termed curb-to-curb) needs.

### **Ventura Intercity Service Transit Authority**

The Ventura Intercity Service Transit Authority (VISTA) provides curb-to-curb Dial-A-Ride service for the general public in Santa Paula, Fillmore and Piru seven days per week. VISTA Dial-A-Ride provides service to the general public in the Santa Paula and Fillmore-Piru areas. VISTA Dial-A-Ride also provides curb-to-curb service for certified ADA passengers between the cities of Fillmore and Santa Paula. The Fillmore Area Transportation Corporation is the sub-agency interviewed and provides DRT service to the Fillmore area. VISTA in Fillmore is thus a general public DRT and curb-to-curb service provider.

### **Fresno Area Express**

The Fresno Area Express provides the fixed route and demand response service for Fresno. The demand response service of the Fresno Area Express (FAX), termed HandyRide, is designed to meet the transportation needs of eligible persons with disabilities who cannot functionally use the FAX City bus system. Handy Ride is a shared ride, curb-to-curb service, provided from any origin to any destination throughout the service area for any trip purpose and operates during the same hours and days as the general fixed-route FAX public transportation system.

### **Norwalk Transit System**

The Norwalk Transit System (NTS) provides fixed route and Dial-A-Ride service to Norwalk and surrounding communities. On November 1974, NTS's demand-responsive transit service (DRT) for persons with disabilities was initiated. Dial-A-Ride service is available for persons with disabilities and senior citizens from 7:00 a.m. to 7:00 p.m. on weekdays and from 9:00 a.m. to 5:30 p.m. on weekends. Norwalk currently outsources the day-to-day operations of the Dial-A-Ride service to the private contractor, MV Transportation.

## **5.2 Field Case Study and Interview Results**

All five DRT systems surveyed use Trapeze computer-aided scheduling and dispatch software to aid in reservations, scheduling and dispatch, and reporting. To complement the Trapeze software, all of the DRT systems interviewed utilize mobile data terminals (MDT's) through which most of the communications between dispatchers and drivers are carried out.

### **Reservations**

The reservation processes of all five DRT agencies included taking reservations live over the phone. The only difference in the reservation processes of the five DRT systems is that the Fillmore Area Transportation Corporation allows walk-up reservations in which customers can approach DRT vehicles and request a new ride and depending on availability and scheduling, dispatchers can accept or reject the request.

The DRT agencies have varied advance reservation requirements. The Fillmore Area Transportation Corporation has no advance reservation requirement, allowing for same day reservations along with walk-up service. The other DRT agencies interviewed have minimum reservation requirements but specified no maximum requirement. The specific reservation requirements of each DRT operator are presented in Table 5-3. Three operators (ASI, FAX, and the Fillmore Area Transportation Corporation) allow subscription service.

Table 5-3: Reservation Requirements among Selected DRT Operators

| <b>DRT Operator</b>   | <b>Advance Reservation Requirement</b>  | <b>Subscription Service Allowed?</b> |
|---|---|--------------------------------------|
| Los Angeles - Access Services Incorporated (ASI)  | <ul style="list-style-type: none"> <li>• Minimum 1 day in advance</li> </ul>  | Yes                                  |
| Orange County Transportation Authority(OCTA): ACCESS  | <ul style="list-style-type: none"> <li>• Minimum 3 days in advance</li> </ul>   | No                                   |
| Fresno Area Express (FAX)   | <ul style="list-style-type: none"> <li>• Minimum 1 day in advance</li> </ul>  | Yes                                  |
| Fillmore Area Transportation Corporation of The Ventura Intercity Service Transit Authority (VISTA) | <ul style="list-style-type: none"> <li>• Same day, walk-ups allowed</li> </ul>  | Yes                                  |
| Norwalk Transit System  | <ul style="list-style-type: none"> <li>• 7 days for medical/school/work</li> <li>• 72 hours in advance for regular service</li> </ul> | No                                   |

### Scheduling and Dispatch

The five DRT operators interviewed were all very similar in terms of their usage of CASD systems for scheduling and dispatch. All of the agencies utilize Trapeze CASD software and rides are scheduled through the allocation of time blocks for each agency. The allocated time blocks are uniform at 30 minutes for all but one of the agencies, ASI, which allocates 20-minute time blocks.

The Drivers and dispatchers for all five of the DRT agencies have the ability to communicate at pick-up, drop-off, and en-route. Communication is conducted primarily through the use of Mobile Data Terminals (MDT) but also through direct radio contact. Reasons

for communication range from simple notification and confirmation of pick-up and drop-off (via MDT) to the report of no-shows and arranging for dispatchers to call the no-shows to inform them that their rides arrived; the latter is done through direct radio contact. Every operator interviewed expressed the desire to keep radio contact to a minimum and utilize the MDTs for the majority of communication in order to minimize driver distraction and maximize efficiency. The most typical reasons for direct communication between dispatchers and drivers were no-shows and adjustments to the schedules. The use of automated phone reminders or verification is a tool that none of these DRT agencies had implemented to date. Table 5-4 is a summary of scheduling and dispatch characteristics of the DRT operators.

Table 5-4: Scheduling and Dispatch Characteristics of Selected DRT Operators

| <b>DRT Operator</b>                      | <b>Use of CASD System</b> | <b>How Rides are Scheduled (Time Block Length)</b> | <b>Operator &amp; Dispatch Communication (via MDT or Radio)</b>   |
|--|---------------------------|--|---|
| ASI                                      | Yes                       | 20 minutes   | <ul style="list-style-type: none"> <li>• Confirmation of pick-up and drop-off,</li> <li>• report of no-shows,</li> <li>• estimated time of arrival</li> </ul>                                       |
| OCTA-ACCESS                              | Yes                       | 30 minutes   | <ul style="list-style-type: none"> <li>• Confirmation of pick-up and drop-off,</li> <li>• report of no-shows,</li> <li>• schedule contacting of customers who are not present at pick-up</li> </ul> |
| FAX                                      | Yes                       | 30 minutes   | <ul style="list-style-type: none"> <li>• Confirmation of pick-up and drop-off,</li> <li>• report of no-shows,</li> <li>• verification of changes</li> </ul>   |
| Fillmore Area Transportation Corporation | Yes                       | 30 minutes   | <ul style="list-style-type: none"> <li>• For no-shows,</li> <li>• schedule changes, and cancellations</li> </ul>  |
| Norwalk Transit System                   | Yes                       | 30 minutes   | <ul style="list-style-type: none"> <li>• Confirmation of pick-up and drop-off,</li> <li>• report of no-shows</li> </ul>   |

The complexities and issues most commonly encountered in scheduling and dispatching differ for each agency. The Fillmore Area Transportation Corporation frequently encounters difficulties accommodating the number of requests that they receive due to their limited resources in terms of reservationists who also serve as dispatchers. The Norwalk Transit System similarly experiences issues accommodating the number of requested trips, more specifically

the negotiation of and lack of availability of same day trips. OCTA-ACCESS identified the negotiation of the pick-up windows for peak periods of demand as the most common issue they encountered in scheduling and dispatch. All five agencies noted that no-shows are a significant problem that leads to reduced efficiency which can only be mitigated through scheduling policies and time windows for service, but never fully eliminated. None of the agencies noted any problems with the CASD software and were satisfied with Trapeze’s capabilities in terms of scheduling.

### Routing

The five DRT agencies route their vehicles using sequential pick-up/nearest drop-off routine and rides are linked using the Trapeze software. Subscriptions are batch scheduled and demand trips are subsequently taken daily and then sequenced with the batched trips using the Trapeze scheduling software. Table 5-5 is a summary of routing characteristics

Table 5-5: Routing Characteristics of Selected DRT Operators

| <b>DRT Operator</b>                      | <b>Use of CASD System</b> | <b>Routing Method</b>       | <b>Linking of Rides</b>   |
|--|---------------------------|-----------------------------|---|
| ASI                                      | Yes                       | Sequential pick-up/Drop-off | Batch scheduled, demand trips linked day prior to service using Trapeze   |
| ACCESS                                   | Yes                       | Sequential pick-up/Drop-off | Batch scheduled, demand trips linked day prior to service using Trapeze   |
| FAX                                      | Yes                       | Sequential pick-up/Drop-off | Batch scheduled, demand trips linked day prior to service using Trapeze   |
| Fillmore Area Transportation Corporation | Yes                       | Sequential pick-up/Drop-off | Batch scheduled, demand trips linked day prior to service using Trapeze. Cancellations and gaps in the schedule filled manually for same day service. |
| Norwalk Transit System                   | Yes                       | Sequential pick-up/Drop-off | Batch scheduled, demand trips linked day prior to service using Trapeze   |

### Reporting

There are slight differences in the manner of reporting and the data reported by individual agencies. The Fillmore Area Transportation Corporation uses a combination of media for recording data, which includes paper and electronic. Information that is reported on paper

includes the driver logs, which are taken by hand and then converted into electronic format when entered into excel. The other DRT agencies store data strictly electronically. Table 5-6 presents a summary of the specific data stored by the agencies.

Table 5-6: Items and Media of Data Storage by Selected DRT Operators

| <b>DRT Operator</b>                      | <b>Electronic Reporting</b> | <b>Paper Reporting</b> | <b>Data Reported</b>  |
|--|-----------------------------|------------------------|---|
| ASI                                      | Yes                         | No                     | <i>Calls received<br/>Calls un-accommodated<br/>Calls denied<br/>Calls served<br/>No pick-ups<br/>Late cancelations</i> |
| OCTA-ACCESS                              | Yes                         | No                     | <i>Calls received<br/>Calls un-accommodated<br/>Calls denied<br/>Calls served<br/>No-show calls<br/>No pick-ups</i>     |
| FAX                                      | Yes                         | No                     | <i>Passenger count<br/>Scheduled trips<br/>No shows<br/>Cancelled trips<br/>Missed trips<br/>Ride times</i>             |
| Fillmore Area Transportation Corporation | Yes                         | Yes                    | <i>Calls received<br/>Calls un-accommodated<br/>Calls denied<br/>Calls served<br/>No-show calls<br/>No pick-ups</i>     |
| Norwalk Transit System                   | Yes                         | No                     | <i>Calls un-accommodated<br/>Calls denied<br/>Calls served<br/>No-show calls<br/>No pick-ups</i>                        |

### 5.3 Conclusion

The model agencies surveyed were different in size yet very similar in terms of their CASD software use, overall operations, and frequently encountered problems. The similarities in their operations are most likely due to their use of the same Trapeze CASD software which offers each individual agency the same capabilities and constraints. The Trapeze software enables these agencies to efficiently manage ride requests, match the rides to specific drivers and

routes and store daily operations information. A common comment of the DRT agencies surveyed was that even with the Trapeze software, appropriately trained and skilled dispatchers and reservationists are essential due to the frequent updates to service caused by canceled rides and no-shows.

Two of the agencies interviewed, ASI and the Ventura Intercity Service Transit Authority (VISTA) have broken their service area into smaller territories, each with their own area specific DRT agency to serve them. The Fillmore Area Transportation Corporation is one of the agencies that serve a sub-area of the VISTA DRT service area. ASI utilizes sub-areas as well with service areas consisting of 6 sub-areas which include the Santa Clarita area, the Antelope Valley area, the San Fernando Valley area, the southern region, the west-central region, and the eastern region. For service outside designated areas, the pick-up and drop-off policy allows only for drop-offs; all pick-ups must originate in the designated service area.

While the ASI service areas are still very large when separated into sub-areas, the VISTA sub-areas approach the size of the smallest DRT agencies based on the number of vehicles needed to serve the areas. From the performance measures assessed in the data analysis section the trend is apparent that as the size of the agency increases the operating cost per passenger (the most telling performance measure) increases. This justifies further research into the ideal service area size that will maximize the efficiency of DRT service, and if breaking the larger areas into sub-areas will in-itself increase the performance of larger DRT services.

## **6.0 Recommendations**

### **6.1 Introduction**

The following subsections set forth a set of recommendations based on the combination of: (a) attempting to address the frequently encountered problems by DRT operators; (b) dial-a-ride best practices and recommended improvements; and (c) interview findings from model Dial-A-Ride agencies. The development of a CASD system that is modeled after best practices of other Dial-A-Ride agencies and also addresses the shortcomings that this type of service generally encounters can result in a more efficient CASD systems and a more productive Dial-A-Ride agency.

### **6.2 Reservations**

The reservation process for the model California Dial-A-Ride agencies consisted of telephone reservation lines and interaction with reservationists to schedule pick-ups. This proved to be troublesome for some of the agencies due to large call volumes and a lack of funding which prevents the hiring of additional reservationists. TCRP Report 124 (2008) also identifies DRT operator compensation as an issue that can lead to the reduction in efficiency of DRT systems. Low compensation leads to high turnover rates of approximately 30% to 50% a year, which necessitates the use of resources constantly for recruitment and training. Several of the smaller agencies who relied on few reservationists explicitly stated that their highly skilled and experienced reservationists constituted one of the main reasons for the successes of the systems. Interactive Voice Response system should be incorporated into the reservation process in order to alleviate some of the demands placed upon reservationists and allow for them to focus solely on scheduling trips.

Cancellations within the DRT system are extremely detrimental to the productivity of operations when that vacated capacity could not be re-used through the scheduling of additional trips. The strategy suggested by TCRP Report 124 (2008) entails shortening the advance reservations to as low as 3 days prior to scheduled trips. Several performance



improvements were reported by surveyed DRT systems including fewer advance cancellations, fewer no-shows, and the reduction of staff time dedicated to re-scheduling and cancelling trips.

In order to further mitigate no-shows, which can be so detrimental to the productivity of the system, policies should be enacted that will reduce their occurrence. The range of policies adopted by individual agencies varies widely from suspension of service when an individual's no-shows surpass a set threshold to fines and charges for no-shows. DRT systems that assessed penalties demonstrated performance improvements with the reduction of no-shows and late cancellations that in turn resulted in improved productivity for the DRT systems as a whole. (TCRP Report 124, 2008)

Other key components of a successful CASD system include the incorporation of a pre-scheduled subscription service for customers who make multiple trips per month from specific origins to specific destinations. This further alleviates the demand placed on reservationists but also requires a strict no-show policy which would cancel subscription service capabilities for customers that miss a certain number of pick-ups.

### **6.3 Scheduling**

In a computerized system it is most efficient to perform scheduling and dispatching in unison. Performing the functions jointly enables times promised to patrons to be based on dispatching, that is, the assignment of the trip to an actual vehicle. Batch scheduling is the most commonly used method of scheduling and is usually performed through the CASD software package in use by the Dial-A-Ride agency. Trips are batched and scheduled the day prior to service. Automated schedule development should be able to incorporate variables such as individual customer needs, individual driver efficiency and traffic conditions at various times during the day in order to maximize productivity. It is essential that the schedule be reviewed by experienced employees in order to ensure that any adjustments that are needed occur. This type of scheduling necessitates the ability to provide follow-up contact with passengers in order to inform them of their scheduled pick-up time. The use of Interactive Voice Response

technology simplifies the call-back process and reduces the number of employee hours needed to accomplish this portion of the scheduling process.

Among the Dial-A-Ride agencies interviewed, the most productive operations allowed for same day scheduling of trips. Allowing same day trip scheduling lowers pent up demand and reduces the practice of some passengers booking extra trips in order to keep their future travel options open and later canceling unneeded trips. Same day scheduling necessitates highly skilled reservationists who are able to manipulate the schedule to not affect the batched schedule while adding or filling vacancies. It is also important to allow reservationists the flexibility of negotiating pick-up times with customers during their first point of contact.

## **6.4 Dispatching**

The dispatching portion of the CASD system serves as the operation center where dispatchers must be able to address unforeseen issues or interruptions to service that could potentially detract from the system's efficiency and timeliness. A common thread that run through all model Dial-A-Ride agencies interviewed was their reliance on Mobile Data Terminals and Automatic Vehicle Location. The combination of these two technologies enables the agency and dispatchers to monitor the operators of the vehicles during the daily schedule and confirm pick-ups and drop-offs and notify them of no-shows without communicating directly by radio. Radio contact should be reserved for emergencies and resolving scheduling issues which cannot be accomplished over the MDT. Radio contact should be kept to a minimum in order to minimize driver distraction and maximize efficiency. In order to address changes and disruptions to service, it is necessary to have highly skilled on-call dispatchers which have the ability to communicate directly with vehicle operators and alter the schedule if necessary.

## **6.5 Reporting**

An essential component of CASD systems is the potential for increased efficiency based on internal management. To gain the most from vehicle reporting functions, it is suggested that systems are able to collect real-time operational data. Fully integrated real-time data storage and reporting component should be a part of CASD systems to record information from all phases of the Dial-A-Ride process. A strategy recognized by TCRP Report 124 (2008) as an effective management action to improve DRT performance is ensuring that the supply of service, as measured by revenue hours, matches expected demand for service, as measured by passenger trips. In order to successfully implement this management action ridership patterns by day, month, and season must be understood which will then allow for DRT systems to schedule service to match expected ridership patterns. Incorporating CASD features that log and monitor trip data will enable systems to establish ridership patterns which are necessary to implement the suggested management action of matching the supply of revenue hours and demand. This real-time integrated method of reporting will allow for large amounts of data to be easily stored electronically and analyzed for an assessment of the performance of the Dial-A-Ride system in terms of its successes and its shortcomings.

## **6.6 Operator Training and Intuitive User Interface**

The CASD systems on the market provide the ability to perform many of the functions detailed above yet they are not always utilized in a manner which maximizes their benefit. In order to create a CASD system that will be utilized to its greatest potential a combination of extensive training and an intuitive and easy to use interface are necessary.

## **7.0 Concept of Operations**

### **7.1 Introduction**

This section describes the concept of operations (CONOPs) for the smart Dial-A-Ride operating system. The description follows the standard format for CONOPs, which includes visions, goals operational characteristics and operational characteristics of the proposed system.

### **7.2 Vision**

The vision for the smart Dial-A-Ride system is a widely available, community-wide vehicle sharing scheme. It would consist of a widely deployed real-time scheduling & routing system that can help users transition from over dependency on the automobile for most travel needs to the following changes in mode choice:

- a. Obtaining improved connectivity to line-haul services provided by fixed-route lines;
- b. Substituting for short drive trips that are either impractical to walk or bike because of separation of activity centers or for which existing fixed route service is non-existent or cumbersome to use.

### **7.3 Goals and Objectives**

The goal is “a ubiquitous shared-vehicle system capable of door-to-door and connector service for the use of the broad population of residents”. The following objectives can help realize the vision and goal for the smart Dial-A-Ride system:

- a. Provide door-to-door, shared-ride mobility for the growing population of senior citizens to conveniently access personal business, medical, shopping, social and recreational activities

- b. Provide an alternative means of travel in the form of door-to-door, shared-ride mobility to the general population for reaching desired activities for desire lines of travel not served by fixed-route transit
- c. Provide an alternative means of travel in the form of shared-ride mobility to the general population for accessing fixed-route public transit and other forms of public transportation services

## **7.4 Operational Philosophies**

Instead of segmentation of service type by eligibility, the smart Dial-A-Ride system would be available to all as a public carrier service. All service would be reservation-based, but with enough flexibility to accommodate those who require service at short notice. Special runs or times may be reserved for such target groups as the elderly or the disabled for specific travel needs such as medical appointments or recreational trips. However every attempt would be made to schedule those special reservations during off-peak periods of general demand for service. In areas of much conflict in demand for special and general services, the appropriate number of vehicles would be put into service to accommodate the demand.

## **7.5 Operational Environment**

Smart Dial-A-Ride would operate as a “fully” automated system for which human interaction would be minimally required, but for which the option for human interaction would be readily and predictably available. This is analogous to modern day banking where the customer can transact all routine banking business online or at the automated teller machine (ATM), but has the option to deal with a teller during operating hours. The automated functionality should be available online and via the phone at all times while human interaction may be restricted to normal work hours.

## **7.6 Support Environment**

A sophisticated Dial-A-Ride system would include arrangements with local taxi operators for transfer of demand overload. In this vein, the taxi operation of DRT service would benefit from the centralized smart system setup and operate under the same guidelines as the DRT system. Participating taxi operators can continue to benefit from the automated reservation system during off-business hours of the DRT. Yet customers can rest assured they will receive similar treatment and terms as the DRT service.

## **7.7 Operational Scenarios**

One can imagine several scenarios for the use of smart Dial-A-Ride as a community-wide vehicle sharing system. Here are a few:

- a. A senior citizen has to give up driving upon medical advice. This senior likes to visit the local senior center regularly for lunch and to play board games with a few friends. The senior also likes to play a few holes at the local golf course weekly. The senior makes reservations with DRT not unlike having a standing order for a personal chauffeur for transportation to desired activities. Once a week the group of golfing friends like to take DRT to a restaurant of their choosing and back home. Effectively the DRT is providing the service of a private vehicle, but instead of the private vehicle lying idle when parked by the owner, the DRT is used by other customers in a publicly operated vehicle sharing arrangement.
- b. A family heading out of town by air reserves DRT for a ride to the airport. On the way, the DRT vehicle picks up a couple of other customers whose destinations are in the same general corridor leading to the airport. As the other riders are dropped off, the system is cognizant of the desired time for the family to check in at the airport. On the return trip from the airport the DRT brings back arrivals coming to town.
- c. A resident who routinely commutes to work in a major employment center likes to ride fixed-route transit, but must drive to the nearest transit stop daily. Instead of

- the hassle of looking for parking daily, the resident decides to make reservations for DRT to drop him off at the transit stop and bring him back from that stop in the evenings.
- d. A homemaker goes to the grocery store regularly during the week because she likes to prepare a variety of fresh meals for her family. She spends approximately an hour in the store each time. She decides to call for DRT to drop her off at the grocery store and pick her up when she is done with shopping. That way she does not have to wait for the family car to return before she shops and the family does not have to invest in a second car just so she can use it occasionally for shopping.

## **7.8 Operational System Characteristics**

Smart Dial-A-Ride would be a real-time van and small bus scheduling system that is in nearly all respects similar to the Autonomous Dial-A-Ride Technology (ADART) system, but with the distinct difference that it has the ready option for human interaction during all phases of its operation. The system should automatically and with human intervention, when desired, be able to do the following:

- a. Identify origins and destinations of all passengers onboard or requiring service
- b. Identify vehicle locations
- c. Accept input on route conditions and additional passengers
- d. Recalculate travel time options for decision making related to: (i) going direct to the “next” destination; (ii) detour to “nearest” destination; etc.
- e. Reroute DRT vehicle based on recalculated travel times
- f. Store operational data for analysis

During the human intervention phases, operators should have the flexibility to negotiate pick-up times with customers. There should be an automated phone system for reminding customers of pending pick-up and for prompting response choices from them. The system should be able to use the response to update routing decisions. To limit abuse, the system should have the capability for prepayment at the time of confirmed reservations and the

capability to store credit for those who had to change plans and followed established procedure to cancel (or modify) reservations within an acceptable time leeway.

## **7.9 System Constraints & Limitations**

Like existing operations, smart Dial-A-Ride operations would be constrained by the number of vehicles in service and the extent of the geographical coverage area. Even if funding were available to introduce as many vehicles as demand would dictate, it would take time to determine the optimal numbers of vehicles to be put in service for collections of travel needs of various populations of riders. Another limitation relates to geographical boundaries of operators. For optimal results, smart Dial-A-Ride should be organized as regional systems under which sub-area services are offered for optimality. This concept is similar to the way DRT is operated, for instance, by the Fillmore system in Ventura County.

## **7.10 Institutional Issues**

Existing institutional arrangements for DRT service would need to be revamped for smart Dial-A-Ride. It could be tailored to the geographical coverage and capital resources of many existing operators, but drastic reorganization would be called for in many areas. Analysis of existing DRT operators revealed that some of the very large and the very small DRT operations are among the least performing. The research also revealed that the larger the population served, the better the performance. These reasons explain why umbrella, regional systems need to be established for the largest pools of potential riders, but be subdivided into sub-area systems for operational efficiency in the assignment of optimal territories for groups of vehicles.



## References

- Dial, Robert B. and Gisela, Ghani Ghani. "ADART Order Entry System." 2003.
- Dial, Robert B. "Autonomous Dial-A-Ride Transit: Technical Overview." Transportation Research Part C: Emerging Technologies 3.5 (1995): 261-275.
- Federal Transit Administration, National Transit Database, 2008
- Ghani, Gisela and Robert Dial. "ADART Order Entry System." 2003.
- Goodwill, J.A. and Holly Carapella. Creative Ways to Manage Paratransit Costs. Final Report. Washington D.C.: U.S. Department of Transportation, 2008.
- Lave, Roy and Rosemary Mathias. State of the Art of Paratransit. Washington D.C.: Transportation Research Board, 2000.
- Lave, Roy E., Roger Teal and Patrisha Piras. TRCP Report 18: A Handbook for Acquiring Demand-Responsive Transit Software. Washington D.C.: National Academy Press, 1996.
- Multisystems. Innovative Practices in Paratransit Service. Washington D.C.: Easter SEALS Project Action, 2002.
- Nuworsoo, Cornelius, Kevin Fang, Erin Cooper, Sudeshna Mitra and Eugene Jud, *Providing Senior Citizen Mobility at Minimum Public Cost*, Final Report, Prepared for Leonard Transportation Center, September 2009
- Pagano, Anthony M. and Paul Metaxatos. Computer-Aided Scheduling and Dispatching System: Impacts on Operations and Coordination. Chicago: University of Illinois at Chicago, 2000.
- Pagano, Anthony M., Paul Metaxatos and Mark King. Computer-Aided Scheduling and Dispatching System: Impacts on Operations and Coordination. Chicago: Urban Transportation Center, 2000.
- Pagano, Anthony M., Paul Metaxatos and Mark King. "How Effective Are Computer-Assisted Scheduling and Dispatching Systems in Paratransit?" Transportation Research Record 1760 (2001): 100-106.

Research and Innovative Technology Administration. Examples of Current Technological Deployments. 2 December 2009. 18 December 2009

<[http://www.its.dot.gov/itsweb/msaa/msaa2/chapter3\\_4.htm](http://www.its.dot.gov/itsweb/msaa/msaa2/chapter3_4.htm)>.

Rosenbloom, S. (2003), The Mobility Needs of Older Americans: Implications for Transportation Reauthorization. Retrieved November 6, 2008 from [http://www.brookings.edu/reports/2003/07transportation\\_rosenbloom.aspx](http://www.brookings.edu/reports/2003/07transportation_rosenbloom.aspx)

Transit Cooperative Research Program. Computer-Aided Scheduling and Dispatch in Demand-Responsive Transit Services. Washington D.C.: Transportation Research Board, 2004.

Transit Cooperative Research Project (TCRP), TCRP Synthesis 57: Computer-Aided Scheduling and Dispatch in Demand-Responsive Transit Services. Synthesis. Washington D.C.: Transportation Research Board, 2004.

Transit Cooperative Research Project (TCRP) Report 124, Guidebook for Measuring, Assessing, and Improving Performance of Demand-Response Transportation (Urban Areas), Washington D.C.: Transportation Research Board, 2008

Transit Cooperative Research Project (TCRP) Report 136, Guidebook for Rural Demand-Response Transportation: Measuring, Assessing, and Improving Performance, Washington D.C.: Transportation Research Board, 2009

## Appendix to Chapter 2: Definition of Terms

### Appendix 2-1: NTD Definitions of Incidents

#### *Accidents*

The NTD term for accidents is **incidents**, and its definition is very specific, including the existence of one or more specifically defined conditions, such as injuries, fatalities and non-arson fires. The NTD safety-related data items differ from the other data items in that FTA does not make the reported data available to the public at the individual system report level. Those interested in reviewing the safety records of other transit systems cannot use posted electronic spreadsheets and databases to make safety performance comparisons among individual transit systems as they can for other NTD data items. However, since common definitions are used, data requests can be made to the transit systems.

NTD distinguishes incidents as either major or non-major, and urban DRT systems must report both types of incidents.

**Definition:** An incident is an event and can involve multiple people and vehicles. An event is defined as a safety incident if it involves a transit vehicle or occurs on transit-controlled property and meets one of the following thresholds:

**A major incident** is defined by NTD as:

- A fatality other than a suicide,
- An injury requiring immediate medical attention away from the scene for two or more persons,
- Property damage equal to or exceeding \$25,000,
- An evacuation of a revenue vehicle due to life safety reasons,
- A collision at a grade crossing,
- A mainline derailment,
- A collision with person(s) on rail right-of-way (ROW) resulting in injuries that require immediate medical attention away from the scene for one or more persons, and
- A collision between a rail transit vehicle and another rail transit vehicle or a transit nonrevenue vehicle resulting in injuries that require immediate medical attention away from the scene for one or more persons.

It is noted the last three conditions are not applicable to DRT

**A non-major incident** is defined as the existence of one or more of the following:

- An injury requiring immediate medical attention away from the scene for one person,
- Property damage equal to or exceeding \$7,500, but less than \$25,000 (since that would mean the incident becomes major), and
- All non-arson fires.

**Discussion of Definition:** An important element of this definition is that the accident must involve a transit vehicle or occur on transit-controlled property. This means that the accident occurs in an environment under the direct control of the transit system. For DRT systems, this definition typically limits the counting of accidents to those involving transit vehicles since most DRT systems do not own or control other transit facilities such as stations, buildings, or shelters.

Source: TCRP Report 124, 2008, page 20

## Appendices to Chapter 3: Interviews with Central Coast Operators

### Appendix 3-A: Operator Interview Template

#### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: \_\_\_\_\_

Name/ Title: \_\_\_\_\_

Date: \_\_\_\_\_

Time: \_\_\_\_\_

#### General Information

Number of vehicles operated daily?

Number of dispatchers?

Number of reservationists?

Other employees for operations?

#### Reservations

1. How do you take reservations?
2. How long in advance are reservations required (subscription service versus new trips)?

#### Scheduling & Dispatching

3. How do you schedule various rides?
  - Allocate time blocks (e.g. 15 to 30 min.)
  - Dynamic
4. Do you use any computer aided scheduling and dispatch (CASD) systems?

5. Do you have an automated phone system for reminders or verification calls to customers?
  - Do you contact riders at pickup?
6. How frequently do the vehicle operator and dispatcher communicate? And for what reasons?
  - At pick-up
  - At drop-off
  - En-route

### **Routing**

7. How are the vehicles routed?
  - 1<sup>st</sup> pick-up/ 1<sup>st</sup> drop-off
  - Sequential pick-up/ nearest drop-off
  - Pick-up/ prioritized by scheduled arrival time
8. When and how do you decide to link rides, such as new trip requests and pre-existing subscribed orders?

### **Monitoring and Reporting**

9. How do you report and store passenger and daily operations data?
  - On paper or electronic data

#### 9a. What Kinds of operations data do you report/ store?

- Calls received
- Calls not accommodated
- Calls denied
- Calls served
- No-show calls
- No pick-ups

### **General Operations**

10. Any additional Technology/Software used that has not been discussed for:
  - Reservations
  - Scheduling

- Dispatching
- Routing

10a. And if so, any problems encountered in implementing the software for:

- Reservations
- Scheduling
- Dispatching
- Routing

11. What issues, if any, do your operators or customers experience frequently?

- With scheduling?
- With routing?
- With timing?
- With no-shows?

12. How successful do you feel your operations are at serving customer requests on a day to day basis? Why or why not?

## Appendix 3-B: Interview Results – Paso Robles DRT

### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: Paso Robles Dial-A-Ride (Run by Paso Express)

Name/ Title: Terry Gillespie, General Manager First Transit

Date: February 10, 2010

Time: 10:00am – 10:30am

#### General Information

Number of vehicles operated daily? 1

Number of dispatchers? 1

Number of reservationists? 1

Other employees for operations?

#### Reservations

1. How do you take reservations?
  - By phone, then on a piece of paper that gets put into that days schedule.
2. How long in advance are reservations required (subscription service versus new trips)?
  - At least 2 hours in advance
  - No longer than 1 week in advance ride reservations
  - With one bus there is not a lot of flexibility

#### Scheduling & Dispatching

3. How do you schedule various rides?
  - ✓ Allocate time blocks (e.g. 15 to 30 min.)
  - May sometimes have to negotiate times for ride pick-ups when taking a reservation to fit it into the schedule. Do not deny any rides.
  - Dynamic

4. Do you use any computer aided scheduling and dispatch (CASD) systems?  
No. Such a small Dial-A-Ride operation that it is not seen as necessary. Fixed-route buses seem to be sufficient.
  
5. Do you have an automated phone system for reminders or verification calls to customers?  
No
  - Do you contact riders at pickup? No
  - Will wait 2 minutes and if a no-show then dispatch will send the driver forward on schedule
  
6. How frequently do the vehicle operator and dispatcher communicate? And for what reasons?
  - ✓ At pick-up - every time
  - ✓ At drop-off –every time
  - ✓ En-route – Only if change of schedule.

### Routing

7. How are the vehicles routed?
  - 1<sup>st</sup> pick-up/ 1<sup>st</sup> drop-off
  - ✓ Sequential pick-up/ nearest drop-off
  - ✓ Pick-up/ prioritized by scheduled arrival timeTry to maintain a circular route through city, as opposed to a zigzag route.
  
8. When and how do you decide to link rides, such as new trip requests and pre-existing subscribed orders?
  - Schedule pick-ups and drop-offs and try to group rides that are going to the same destinations.

### Monitoring and Reporting

9. How do you report and store passenger and daily operations data?
  - ✓ On paper
  - ~~—Electronic data~~
  - ~~—Other~~
  - ~~—No storage~~



9a. What Kinds of operations data do you report/ store? (**Check all that apply**)

- ✓ Dispatch logs
- ✓ Rides scheduled (pick-ups & drop-offs)
- ✓ Lifts
- ✓ Cancelations
- ✓ No-shows

### General Operations

10. Any additional Technology/Software used that has not been discussed for: **N/A**

- Reservations
- Scheduling
- Dispatching
- Routing

10a. And if so, any problems encountered in implementing the software for: **N/A**

- Reservations
- Scheduling
- Dispatching
- Routing

11. What issues, if any, do your operators or customers experience frequently?

- With scheduling?
- With routing?  
With timing? Fixed route service sometimes gets behind schedule because of road conditions (traffic or road work), but the Dial-A-Ride service has such flexibility in routing that this usually can be avoided.
- With no-shows? Occasional no-shows (Some repeat offenders that are tracked)

12. How successful do you feel your operations are at serving customer requests on a day to day basis? Why or why not?

- Feel since it is such a small operation that if any problems or issues come up they are easily solved.

### **Additional Information about Services**

- Curb to curb operations (not door-to-door)
- Riders generally consist of 40% senior, 40% disabled, and 20% general public





## Appendix 3-C: Interview Results – Ride-On, San Luis Obispo County

### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: Ride-On, San Luis Obispo- Mostly Private-United Cerebral Palsy Service is Non-Profit

Name/ Title: Ana/ Operations Manager

Date: 02/01/2010

Time: 9:00am – 10:00am

#### General Information

Number of vehicles operated daily? 88 vehicles (60 14 passenger vans)

Number of dispatchers? 3

Number of reservationists? 2

Other employees for operations? Mobility Manager

#### Reservations

1. How do you take reservations?

- Ride request form filled out at time of call and given to dispatchers to input into computer software and to schedule.
- Customer information remains in software and will pop up when name entered in (can view all rides that have been requested)

2. How long in advance are reservations required (subscription service versus new trips)?

- If can accommodate, will take last minute requests; also depends on service (e.g. if for event at least a week in advance, if normal ride at least 2 hours in advance)
- Do not schedule individual repeat (subscription) rides
- Certain services like Dialysis, Vets Express, and senior ride services are automatically inserted into scheduling system each week. These services are semi-fixed services where pick-up times, days, and places are advertised for certain groups.

## Scheduling & Dispatching

3. How do you schedule various rides?
  - ~~—Allocate time blocks (e.g. 15 to 30 min.)~~
  - ✓ Dynamic
  
4. Do you use any computer aided scheduling and dispatch (CASD) systems?
  - Use Route Match TS 4.1.5
  - Brand new system (had for 6 months)
  - Got grant for mobile systems in the buses/vans (will be installing this year)
  
5. Do you have an automated phone system for reminders or verification calls to customers?
  - No automated phone system
  - Do you contact riders at pickup?
    - Only contact riders if they do not come out within 3 or so minutes (driver will contact dispatchers who will then call the customer)
    - Riders are given a sheet to call and confirm ride
    - Most customers are repeat and drivers get to know who they are picking up (know that certain people take longer to get out of house than others, etc.)
  
6. How frequently do the vehicle operator and dispatcher communicate? And for what reasons?
  - ✓ At pick-up
    - No-shows
  - ~~—At drop-off~~
  - ✓ En-route
    - For add-ons
    - For dispatcher to locate driver location
    - Any other random problems/ issues with scheduling

## Routing

7. How are the vehicles routed?
  - ~~—1<sup>st</sup> pick-up/1<sup>st</sup> drop-off~~
  - ✓ Sequential pick-up/ nearest drop-off
    - Scheduling system will do some of the work and then dispatchers will have to fill in the gaps.
    - Computer system has increased efficiency significantly
  - ~~—Pick-up/ prioritized by scheduled arrival time~~
  
8. When and how do you decide to link rides, such as new trip requests and pre-existing subscribed orders?
  - Every day drivers are given their schedule of rides and routes.

- When things change (ride cancelations and additions), dispatchers will fit people in where there is room and time, and will assign rides to a drivers schedule. Then will contact driver to notify change in schedule.
- Also have “floater” drivers that they assign to random rides that come up that day.

### Monitoring and Reporting

9. How do you report and store passenger and daily operations data?

- ✓ On paper – Daily operations such as no-shows are reported on paper by driver than either dispatched in or typed into computer later depending upon what it is.
- ✓ Electronic data
- ~~— Other~~
- ~~— No storage~~

9a. What Kinds of operations data do you report/ store? (**Check all that apply**)

- ✓ Calls received
- ✓ Calls unaccommodated
- ✓ Calls denied
- ✓ Calls served
- ✓ No-show calls
- ✓ No pick-ups

### General Operations

10. Any additional Technology/Software used that has not been discussed for:

- ~~— Reservations~~
- ~~— Scheduling~~
- ~~— Dispatching~~
- Routing

10a. And if so, any problems encountered in implementing the software for:

- ~~— Reservations~~
- ~~— Scheduling~~
- ~~— Dispatching~~
- ~~— Routing~~

What issues, if any, do your operators or customers experience frequently?

- With scheduling?
- With routing?
- With timing?
- With no-shows? N/A

In reference to the Route Match software discussed in Q4:

- Dispatchers are displeased with software- feel as though it is not compatible with the services that ride-on provides. Meaning that because of the different services, the computer does not schedule and route effectively. Dispatchers will have to input rider data and date/time that they want a ride in one screen; then the system produces a suggested route/driver. Then dispatcher will have to go and drag the ride request time into the screen with the drivers and put it into a time slot.
- Dispatchers seem extremely frustrated with computer system, but feel that when they get the mobile units it will improve things. The mobile units will do several things:
  - reduce communication between dispatcher and driver;
  - Allow driver to electronically input customer/ride information into system so dispatchers will not have to;
  - Allow dispatchers to input rides and change in schedule in system and dispatcher will see it;
  - Let dispatcher know where drivers are through the GPS system in the mobile unit;

11. How successful do you feel your operations are at serving customer requests on a day to day basis? Why or why not?

- Feel that they respond well to demand needs and adjust service accordingly. An example would be the Vets Express service.
  - Mobility Coordinator position is new to work on this area.
- How much data could we collect (Q9a)? (1 month, 6 months, 1 year?)
  - Need to contact Kathy from Business Operations to receive data. Have a year's worth of data.

#### **Additional Information about Services**

- Largest market are senior citizens and then the disabled
- Vets Express is funded solely by fundraising
  - Try to hook up with bus going to LA in the morning and then to pick up at night when bus comes back from LA
- TWT- 5 cities Senior Shuttle
  - Senior Shuttle-
    - Try to accommodate last minute, but like 2 to 3 days' notice

## Appendix 3-D: Interview Results – RTA Runabout, San Luis Obispo County

### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: SLO County Regional Transit Agency (RTA) Runabout and Dial-A-Ride

Name/ Title: Shelly Coabal, Lead Supervisor

Date: February 17, 2010

Time: 10am-10:45am

#### General Information

Number of vehicles operated daily? 13

Number of dispatchers?

- Dial-A-Ride – 1 dispatcher
- Runabout (ADA) – 2 dispatchers

Number of reservationists? 1 specific reservationist/ scheduler

Other employees for operations?

#### Reservations

1. How do you take reservations?
  - By phone, then put into system where repeat customer data is stored or entered
2. How long in advance are reservations required (subscription service versus new trips)?
  - For Dial-A-Ride service- take same day calls (2 hours)
  - For Runabout- 24 hours min. advance & up to a week max. (subscription service allowed)

#### Scheduling & Dispatching

3. How do you schedule various rides?
  - Allocate time blocks (e.g. 15 to 30 min.)



- Dial-A-Ride service, since it responds to same-day calls, is allocated by 15 minute time blocks.
  - Dynamic –
    - Runabout is dynamic, although riders are given a 30 minute time slot when pick-up may occur in which they must be ready when vehicle arrives.
4. Do you use any computer aided scheduling and dispatch (CASD) systems?
- Trapeze software
    - Used for scheduling and routing.
    - On-board computers (not GPS) with real-time scheduling information, but some drivers still like to be dispatched when things change.
    - Drivers input pick-up and drop-off times, fare, and number of passengers.
  - In the process of getting Route Match
5. Do you have an automated phone system for reminders or verification calls to customers? No
- Do you contact riders at pickup? No
    - Used to do call-backs but it took too much time
6. How frequently do the vehicle operator and dispatcher communicate? And for what reasons?
- Only if adjustments in schedule, drivers go on and off breaks, or problems arise (e.g. No show)

### Routing

7. How are the vehicles routed?
- ✓ Sequential pick-up/ nearest drop-off
  - ✓ Pick-up/ prioritized by scheduled arrival time
8. When and how do you decide to link rides, such as new trip requests and pre-existing subscribed orders?
- By timing

### Monitoring and Reporting

9. How do you report and store passenger and daily operations data?
- ✓ Electronic data
- 9a. What Kinds of operations data do you report/ store? (**Check all that apply**)
- ✓ Calls received
  - Calls unaccommodated
  - ✓ Calls denied
  - ✓ Calls served
  - ✓ No-show calls

- ✓ No pick-ups
- ✓ On-time performance
- ✓ Monetary data
- ✓ Passenger counts
- ✓ Cancellations

### General Operations

10. Any additional Technology/Software used that has not been discussed for:

- Reservations
  
  
  
- Scheduling
  
  
- Dispatching
  
  
  
- Routing

10a. And if so, any problems encountered in implementing the software for:

- Reservations
  
  
  
- Scheduling
  
  
  
- Dispatching
  
  
  
- Routing

11. What issues, if any, do your operators or customers experience frequently?

- With scheduling?
  - When a ride is requested the only way to look up the person is by last name, which is difficult to disseminate over the phone sometimes. Would be useful to be able to look up a return rider by address or other information.
  - Some riders, for the Runabout service don't like the 7 day timeframe limitation.
- With routing?
  - For the runabout service, when the software groups rides, it does it by time and not so much by proximity, therefore suggests routes where it sends some drivers across county instead of in same area. This is where the scheduler has to manually adjust.

- With timing?
  - o Customers don't like the 30 minute pick-up timeframes for the runabout service.
- With no-shows?

12. How successful do you feel your operations are at serving customer requests on a day to day basis? Why or why not?

- How much data could we collect (Q9a)? (1 month, 6 months, 1 year?)
  - Raw data sufficient (can compile and return)

### **Additional Information about Services**

- Dial-A-Ride services provided for Nipomo and Los Osos who stay in those communities.
- Dial-A-Ride service riders consist of seniors, low income, and youth.
- Runabout service only provided for ADA approved passengers anywhere in the county

## Appendix 3-E: Interview Results – SMOOTH DRT, Santa Maria

### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: SMOOTH (Santa Maria Organization of Transportation Helpers, Inc.), Non-Profit

Name/ Title: Fil Simas/ Operations Manager

Date: 02/03/2010

Time: 10:00am- 10:30am

#### General Information

Number of vehicles operated daily? Have 20 vehicles

Number of dispatchers? 2 (who perform other jobs as well)

Number of reservationists? Same as dispatchers

Other employees for operations?

#### Reservations

1. How do you take reservations?
  - By phone and then input ride request and rider information into computer based dispatch system (NOVIS, Trapeze software) that does the scheduling.
  - For senior Dial-A-Ride- No complicated requirements (60 yrs or older)- enrolled by phone
2. How long in advance are reservations required (subscription service versus new trips)?
  - About 2 days in advance.
  - Will take last minute reservations if can accommodate.

#### Scheduling & Dispatching

3. How do you schedule various rides?
  - Allocate time blocks (e.g. 15 to 30 min.)
    - o Before computer system would do 15 min. intervals.
  - ✓ Dynamic
    - o With computer system can do dynamic scheduling, much more efficient.

4. Do you use any computer aided scheduling and dispatch (CASD) systems?
  - Use a computer based dispatch system called NOVIS (Trapeze software)
  
5. Do you have an automated phone system for reminders or verification calls to customers?
  - Do you contact riders at pickup?
    - Not usually, only if rider does not come out within a couple minutes
    - Drivers are familiar with riders (repeat riders) and how long it usually takes people to come out.
    - Some drivers may even go to door if person does not show up.
    - Then driver will contact dispatch if there is a no-show and dispatch will call residence of rider.
  
6. How frequently do the vehicle operator and dispatcher communicate? And for what reasons?
  - ✓ At pick-up
    - For no-shows
    - When late or early
  - ✓ At drop-off
    - When late or early
  - ✓ En-route
    - If there is a last minute ride request scheduled in

### Routing

7. How are the vehicles routed?
  - Computer system will route rides
  - 1<sup>st</sup> pick-up/ 1<sup>st</sup> drop-off
    - Used to be the case before computer system was implemented
  - ✓ Sequential pick-up/ nearest drop-off
  - ✓ Pick-up/ prioritized by scheduled arrival time
  
8. When and how do you decide to link rides, such as new trip requests and pre-existing subscribed orders?

### Monitoring and Reporting

9. How do you report and store passenger and daily operations data?
  - ✓ On paper
  - ✓ Electronic data
  - Other
  - No storage
  
- 9a. What Kinds of operations data do you report/ store? (**Check all that apply**)
  - ✓ Ridership
  - ✓ Hours

- ✓ Miles
- ✓ Farebox
- ✓ Calls served
- ✓ No-show calls
- ✓ No pick-ups

### General Operations

10. Any additional Technology/Software used that has not been discussed for:

- Reservations
- Scheduling
- Dispatching
- Routing

10a. And if so, any problems encountered in implementing the software for:

- Reservations
- Scheduling
- Dispatching
- ✓ Routing
  - In reference to the NOVIS software, one glitch at the beginning was with timing of the routes. Initial computer generated time between stops were not correct. Had to manually go in and change, or slow down, the average mph of certain routes to adjust for the realistic time it took. The computer did not take into account delays of the routes like stop lights and such.

11. What issues, if any, do your operators or customers experience frequently?

- With scheduling?
- With routing?
- With timing?
- With no-shows?

12. How successful do you feel your operations are at serving customer requests on a day to day basis? Why or why not?

- Do periodic customer satisfaction surveys
- How much data could we collect (Q9a)? (1 month, 6 months, 1 year?)

### **Additional Information about Services**

SMOOTH does several contract services (about 8) which include some fixed routes:

- Guadalupe flyer- fixed route
- School District (San Bonita)
- Designated as CTSA for County

Largest segment of riders are the disabled.

**SMOOTH Data (Senior DRT)**

**SMOOTH Data (Senior DRT)**

Non-Profit Agency

**July 2008-June 2009**

|                              |                                   |                                      |  |
|------------------------------|-----------------------------------|--------------------------------------|--|
| Ridership                    | 7,095                             |                                      |  |
| Reservations                 | 7,302                             |                                      |  |
| No-Shows                     | 38                                |                                      |  |
| <i>Missed trip (return)</i>  | 5                                 |                                      |  |
| Canceled in advance          | 0                                 |                                      |  |
| Canceled at door             | 169                               |                                      |  |
| Requests Denied              | Not reported                      |                                      |  |
|                              |                                   |                                      |  |
| Vehicle Service Hours        | 4,520                             |                                      |  |
| Vehicle Service Miles        | 49,376                            |                                      |  |
|                              |                                   |                                      |  |
| Revenues                     | \$17,332                          |                                      |  |
| Fare Box Ratio               | 10.49%                            | Other % made up through SMOOTH funds |  |
| Operating Cost (1 month)     |                                   |                                      |  |
| <b>June 2009</b>             |                                   |                                      |  |
| <i>Program cost</i>          | \$13,950                          |                                      |  |
| <i>Riders</i>                | 527                               |                                      |  |
| <i>Vehicle Service Miles</i> | 3802                              |                                      |  |
| <i>Vehicle Service Hours</i> | 408                               |                                      |  |
|                              |                                   |                                      |  |
| Geographic Coverage Area     | City of Santa Maria & Orcutt area |                                      |  |
| Population Served            | 106,253                           |                                      |  |

## Appendices to Chapter 5: Interviews with Efficient Operators

### Appendix 5-1: Interview Results – Orange County Transportation Authority

#### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: Orange County Transportation Authority

Name/ Title: Gracie Davis/ADA Eligibility Coordinator, Robert Gebo/XXXX

Date: July 14, 2010

Time: 3:30 p.m.

#### General Information

Number of vehicles operating daily? *248*

Number of dispatchers? *6 window dispatchers, 9 radio dispatchers, 15 total dispatchers*

Number of reservationists? *18 full-time reservationists, 8 part-time reservationists*

Other employees for operations? *23 admin employees*

#### Reservations

13. How do you take reservations?

*Yes, through reservationists and done live.*

14. How long in advance are reservations required (subscription service versus new trips)?

*All reservations are required to be made at least 3 days in advance.*

#### Scheduling & Dispatching

15. How do you schedule various rides?

*Rides are scheduled through allocated 30 minute time blocks.*



16. Do you use any computer aided scheduling and dispatch (CASD) systems?

*Yes, Trapeze.*

17. Do you have an automated phone system for reminders or verification calls to customers?

*Yes, IVR is available through the Trapeze system but is currently not utilized. It is planned to be incorporated into operations in the future.*

- Do you contact riders at pickup?

*No, the 30 minute window is curb-to-curb thus the patron has to be outside at the designated pick-up spot when their ride arrives.*

18. How frequently do the vehicle operator and dispatcher communicate? And for what reasons?

*The vehicle operator communicates with the dispatcher via MDT at pick-up and drop-off. Most communication is done through the MDT's while direct radio contact is used only when necessary and mostly when en-route.*

### **Routing**

19. How are the vehicles routed?

*Sequential pick-up/ nearest drop-off*

20. When and how do you decide to link rides, such as new trip requests and pre-existing subscribed orders?

*Rides are linked the prior to the day of service and it is done through optimization.*

### **Monitoring and Reporting**

21. How do you report and store passenger and daily operations data?

*Data is reported and stored in electronic form which is one of the functions of the Trapeze system.*

9a. What Kinds of operations data do you report/ store?

*All of the below.*

- Calls received

- Calls unaccommodated
- Calls denied
- Calls served
- No-show calls-Trapeze
- No pick-ups-Trapeze

### General Operations

22. Any additional Technology/Software used that has not been discussed for:

*Trapeze is used to perform all these general operations.*

- Reservations
  
- Scheduling
  
- Dispatching
  
- Routing

10a. And if so, any problems encountered in implementing the software for:

*No problems have been encountered.*

- Reservations
- Scheduling
- Dispatching
- Routing

23. What issues, if any, do your operators or customers experience frequently?

- With scheduling?  
*Negotiating the pick-up window for the peak periods in which service is at its highest demand.*
- With routing?
- With timing?
- With no-shows?

24. How successful do you feel your operations are at serving customer requests on a day to day basis? Why or why not?

*The system runs pretty smoothly and there are no huge weaknesses. This agency serves a lot of customers so the system will always have some problems, but they are relatively minor ones.*

## Appendix 5-2: Interview Results – MV Transportation (Norwalk Transit System)

### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: MV Transportation (Norwalk Transit System)  
Name/ Title: Lina Parten, Manager  
Date: September 8, 2010  
Time: 10:00 am

#### General Information

Number of vehicles operating daily? *5*  
Number of dispatchers? *2*  
Number of reservationists? *1*  
Other employees for operations? *2(Manager and Road Supervisor)*

#### Reservations

1. How do you take reservations?  
*Through reservationists over the phone*
2. How long in advance are reservations required (subscription service versus new trips)?  
*-7 days for medical/school/work*  
*-72 hours in advance for regular service*

#### Scheduling & Dispatching

3. How do you schedule various rides?  
*Through Trapeze*
  4. Do you use any computer aided scheduling and dispatch (CASD) systems?  
*Yes, Trapeze.*
  5. Do you have an automated phone system for reminders or verification calls to customers?  
*No, all reminders are done through by dispatchers*
- Do you contact riders at pickup?

*Patrons are only contacted if they are not outside when their ride arrives. When this occurs the dispatcher will call the phone number provided by the patron.*

1. How frequently do the vehicle operator and dispatcher communicate? And for what reasons?

*They have the ability to communicate at pick-up, drop-off, and en-route. Communication is conducted through the use of Mobile Data Terminals as well as Nextel radios. Reasons for communication range from simple notification and confirmation of pick-up and drop-off (MDT) to the report of no-shows and arranging for a dispatcher to call the no-show to inform them that their ride has arrived (Direct Radio Contact).*

### Routing

2. How are the vehicles routed?

*Sequential pick-up/ nearest drop-off*

3. When and how do you decide to link rides, such as new trip requests and pre-existing subscribed orders?

*All rides are linked using Trapeze and is done the day prior to service.*

### Monitoring and Reporting

4. How do you report and store passenger and daily operations data?

*On paper as well as electronically using the Trapeze software.*

- 9a. What Kinds of operations data do you report/ store?

- *Calls unaccommodated*
- *Calls denied*
- *Calls served*
- *No-show calls*
- *No pick-ups*

### General Operations

1. Any additional Technology/Software used that has not been discussed for:

*No, Trapeze is used to perform all these general operations.*

- 10a. And if so, any problems encountered in implementing the software for:

*NA*

1. What issues, if any, do your operators or customers experience frequently?

- *With scheduling?*

*Negotiation for and the lack of availability of same day trips.*

- With routing?  
*The sharing of rides and routing the vehicles in the most efficient manner*
- With timing?  
None
- With no-shows?  
*This is an issue which can and does frequently affect the scheduling and timeliness of the service. In order to deal with this problem no-shows are recorded and reported to the client (Norwalk Transit System)*

1. How successful do you feel your operations are at serving customer requests on a day to day basis? Why or why not?  
*Overall passengers are pleased with the operation. The service in general is somewhat restrictive in the hours of operation as well having to operate within an allotted number of hours to serve the city.*

## Appendix 5-3: Interview Results – Fillmore Area Transportation Corporation

### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: Fillmore Area Transportation Corporation

Name/ Title: Jacqui Cervantez / Operations Manager

Date: September 22, 2010

Time: 11:00 am

#### General Information

Number of vehicles operating daily? *13*

Number of dispatchers? *2 from 6am-6pm (1 for each City served), 1 from 6pm to 8:30pm*

Number of reservationists? *Done by the dispatchers*

Other employees for operations? *3, 1 human resources, 1 Ops Manager, 1 mechanic*

#### Reservations

- How do you take reservations?

*Through reservationists over the phone, or by walk-up to the actual vehicles during pick-up*

2. How long in advance reservations are required (subscription service versus new trips)?

*-same day for new trips*

*-2 weeks to same day for subscription (as scheduling allows)*

#### Scheduling & Dispatching

3. How do you schedule various rides?

*Allocate 30 minute time blocks within which the pick-up and drop-off must occur.*

4. Do you use any computer aided scheduling and dispatch (CASD) systems?

*Yes, Trapeze and MDT's.*

5. Do you have an automated phone system for reminders or verification calls to customers?

*No reminders or verification is given*

- Do you contact riders at pickup?

No

- How frequently do the vehicle operator and dispatcher communicate? And for what reasons?  
*Communication is done as needed for such instances as no-shows which will affect the scheduling by the dispatcher/reservationist. Most communication is done through MDT's which the vehicles are equipped with in order to minimize the necessary radio contact.*

### Routing

6. How are the vehicles routed?  
*Sequential pick-up/ nearest drop-off which allows for the greatest efficiency in their opinion.*
  
7. When and how do you decide to link rides, such as new trip requests and pre-existing subscribed orders?

### Monitoring and Reporting

8. How do you report and store passenger and daily operations data?  
*On paper as well as electronically. Driver logs show the time and fare and then are converted into electronic form by entering them into excel.*

9a. What Kinds of operations data do you report/ store?

- *Calls received*
- *Calls unaccommodated -also notes whether an alternative time was found*
- *Calls denied*
- *Calls served*
- *No-show calls-If subscription riders miss 3 rides in a row they are taken off of subscription*
- *No pick-ups*

All of this information is stored.

### General Operations

- Any additional Technology/Software used that has not been discussed for:  
No.

10a. And if so, any problems encountered in implementing the software for:

NA

- What issues, if any, do your operators or customers experience frequently?
- With scheduling?

*Accommodating the number of requests that they receive with their limited resources in terms of reservationists who also serve as dispatchers. Sometimes callers can't get through because only two reservationists on two phone lines are available.*

- With routing?

*None*

- With timing?

*None*

- With no-shows?

*None*

- How successful do you feel your operations are at serving customer requests on a day to day basis? Why or why not?

*They do a very good job with the resources that they have in providing service and accommodating the greatest number of passengers as possible. Federal funding has been cut which has led to a cut in the capacity of the operation in terms of number of passengers able to be transported.*



## Appendix 5-4: Interview Results – Access Services Incorporated (LA County)

### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: Access Services Incorporated (LA County)

Name/ Title: Alfredo Torales

Date: October 10, 2010

Time: 1:30 p.m.

#### General Information

Number of vehicles operating daily? *400-500*

Number of dispatchers? *15-20*

Number of reservationists? *50-60*

Other employees for operations? *1000 certified drivers*

#### Reservations

25. How do you take reservations?

*Through reservationists over the phone*

26. How long in advance reservations are required (subscription service versus new trips)?

*All reservations are required to be made at least 1 day in advance. Subscription service is available*

#### Scheduling & Dispatching

27. How do you schedule various rides?

*Rides are scheduled through allocated 20 minute time blocks.*

28. Do you use any computer aided scheduling and dispatch (CASD) systems?

*Yes, Trapeze.*

29. Do you have an automated phone system for reminders or verification calls to customers?

*No*

- Do you contact riders at pickup?

*No, the 20 minute window is curb-to-curb thus the patron has to be outside at the designated pick-up spot when their ride arrives.*

30. How frequently do the vehicle operator and dispatcher communicate? And for what reasons?

*The vehicle operator communicates with the dispatcher via MDT at pick-up and drop-off, and for no-shows and to determine estimated times of arrival. Most communication is done through the MDT's while direct radio contact is used only when necessary and mostly when en-route.*

### **Routing**

31. How are the vehicles routed?

*Sequential pick-up/ nearest drop-off*

32. When and how do you decide to link rides, such as new trip requests and pre-existing subscribed orders?

*Advance reservations are batch routed then subsequent rides are linked the prior to the day of service through optimization.*

### **Monitoring and Reporting**

33. How do you report and store passenger and daily operations data?

*Data is reported and stored in electronic form which is one of the functions of the Trapeze system.*

9a. What Kinds of operations data do you report/ store?

*All of the below.*

- Calls received
- Calls unaccommodated

- Calls denied
- Calls served
- No pick-ups-Trapeze
- Late cancelations

### General Operations

34. Any additional Technology/Software used that has not been discussed for:

*Trapeze is used to perform all these general operations.*

- Reservations
- Scheduling
- Dispatching
- Routing

10a. And if so, any problems encountered in implementing the software for:

*In general there is extensive training and a learning curve associated with the implementation of the software. Another issue is getting parameters to optimal levels.*

- Reservations
- Scheduling
- Dispatching
- Routing

35. What issues, if any, do your operators or customers experience frequently?

- With scheduling?  
*Negotiating the pick-up window*
- With routing?
- With timing?  
*Late pick-ups can become an issue*
- With no-shows?  
*The frequency of no-shows*

36. How successful do you feel your operations are at serving customer requests on a day to day basis? Why or why not?

*The system is one of the best in the country with a 90% on-time arrival rate and very low collision and incident rates.*

## Appendix 5-5: Fresno Area Express HandyRide

### Dial-A-Ride Operator Interview Questions

Smart Dial-a-Ride for Demand-Responsive Transit Operations:  
Research and Development of a Concept of Operations

Agency: Fresno Area Express HandyRide

Name/Title: Kenneth C. Baker, Operations Manager

Date: September 24, 2010

Time:

#### General Information

Number of vehicles operated daily is 44.

Number of dispatchers on staff is 4

Number of reservationists is 4

Additional staff is 2; one scheduler and one supervisor

#### Reservations

1. All reservations are taken by telephone. Hours are 8:00 am to 5:00 pm seven (7) days a week
2. Reservations must be made for next day or up to two days in advance. No same day reservations taken. Subscription request are submitted and processed within 3-5 days. Trips are handled as demand until processed.

#### Scheduling

- 3 Rides are scheduled by Trapeze scheduling. Thirty minute windows are used for eta (0 to 30).
- 4 We are using Trapeze 4.1 currently. Upgrade to Trapeze 10 is programmed this year.
- 5 We do not have an automated phone system for reminders or calls to customers.

6. All vehicles have on-board MDT screens. Operators perform each pick-up and drop using the MDT. Dispatcher/operators use “canned” text via the MDT. Radios are used verify changes, failure of MDT screen, emergency.

### **Routing**

7. Vehicle routes are prepared by Trapeze based on sequential pick-ups and drops.
8. Subscriptions are batch scheduled by Trapeze for five (5) days out. Demand trips taken daily are sequenced with these trips by Trapeze scheduling software. Solutions are given to reservationists who pick the best schedule by time and miles.

### **Monitoring and Reporting**

9. All passenger data is stored on Trapeze and reports generated by Trapeze software. We report passenger count, scheduled trips, no shows, cancelled trips, missed trips and ride times (15 minute windows).

### **General Operations**

10. In addition to Trapeze we use a call monitoring program by Inter-Tel. This displays on a screen in dispatch number of calls waiting, calls answered and calls abandoned.

We use Spider Reports software that displays our on time performance in real time by hour and gives us late trips forecasting.

This software has been in operation for about five (5) years.

### **Issues**

11. The City of Fresno has budget issues just like most communities in California. Transit service has seen a reduction in service through the layoff of bus operators which eliminated six buses a day yet the ridership has increased. Many of our customers are experiencing longer waits for buses to arrive and an increase in ride time.
12. FAX Handy Ride has become a very successful Paratransit system. This is evident in monthly ridership increasing 15% in 2009 from 2007; no shows have decreased from 1730 to 396 per month; passengers per hour has increased from 1.81 to 2.41; on-time performance has gone from 94% in 2007 to 96.4% for 2009. Our customers continue to receive excellent service overall.