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Authors

Teal, Roger F.
Goodhue, Richard E.
Rooney, Steven B.
[et al.](#)

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Taxi-Based Public Transportation for the Elderly and Handicapped

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Roger F. Teal ¹
Richard E. Goodhue ²
Steven B. Rooney ¹
Kia Mortazavi ¹

¹ Department of Civil Engineering and
Institute of Transportation Studies
University of California, Irvine

² Orange County Transportation Commission
Santa Ana, California

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Institute of Transportation Studies
University of California, Irvine
Irvine, CA 92697-3600, U.S.A.
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Abstract

This paper analyzes the system organization, performance, and taxi firm impacts of California's taxi-based elderly and handicapped (E&H) systems, and compares the results to taxi-based general public demand-responsive transit (DRT) systems. The data were gathered from 48 California taxi-based E&H systems. Shared-ride operation is the key to superior system performance, provides the most favorable taxi firm financial impacts and initiates the firm into the paratransit diversification process. In situations with low demand densities, where the sponsor faces a severe total system cost constraint, organizing an ERT system is probably the only feasible strategy. Taxi-based ERT systems are about 25 percent more expensive than taxi-based general public DRT systems, have less impact on firm revenues, and do little to enhance firm evolution.

I. Introduction

Two trends have dominated the recent diffusion of demand-responsive transit (DRT). The first trend is the growing reliance on private contractors, particularly taxi firms, as DRT providers, albeit within the framework of a publicly subsidized and sponsored transit service. The second is the increasing tendency of government sponsors of DRT systems to restrict use of the service to certain population subgroups or individuals, most notably the elderly and handicapped. In a number of communities around the country, these two developments have coincided, resulting in the establishment of a generation of taxi-based restricted ridership DRT systems, typically targeted at elderly and handicapped (E&H) individuals. California alone contains approximately 50 such public transportation systems.

Taxi-based DRT systems for the E&H are not simply a smaller-scale version of general public DRT systems, but instead represent distinctive forms of community level transit. The joint decision to restrict ridership and to use a local taxi firm as provider has a significant effect on system organization and performance. Ridership restrictions reduce demand well below the levels achieved by general public DRT systems, in which the E&H typically comprise no more than 50-60 percent of the passengers. In addition, many sponsors impose restrictions within the E&H category, further decreasing potential demand. The resulting low demand density limits the ability of the provider to practice shared riding and may render it infeasible. In fact, the use of a local taxi firm gives the sponsor the option of simply subsidizing traditional

exclusive ride taxi (ERT) service. In contrast to taxi-based general public DRT systems which are normally subsidized shared-ride taxi (SRT) services, often using vehicles dedicated solely to the DRT system, many taxi-based E&H systems closely resemble ERT operations in their organization, fare structure, productivity achievements, and cost-effectiveness. Moreover, the impacts on participating taxi firms--both financially and in terms of organizational evolution and development--tend to differ significantly between E&H and general public systems.

Taxi-based DRT thus consists of two distinctive forms of paratransit services, of which only one, subsidized SRT for the general public, has previously been subject to comprehensive analysis (1,2). The purpose of this paper is to provide a similar analysis of the issues, both institutional and performance, associated with taxi-based E&H services, quite possibly the most rapidly growing component of taxi-based transit.

This analysis is based on the results of a study of 48 taxi-based E&H systems in California, virtually all such systems currently operating in the state. Data was collected on the operating and financial performance of these systems for the 1979-80 and 1980-81 fiscal years. Information was also obtained (via personal interviews with virtually all sponsors and providers) on the process leading to the establishment of these systems, the impacts on the involved taxi firms of participation in public transportation, and the nature and evolution of the public-private sector relationship. These California systems not only represent the

largest single data base available for analysis of taxi-based E&H services; they also offer the advantages of geographic and organizational diversity as well as relative longevity.

In analyzing California's experiences with taxi-based E&H services, our focus has been on three major issue areas. System organization issues include the sponsor's rationale in restricting service instead of making it available to the general public, the institutional reasons for utilizing a taxi firm to deliver the service, and the factors which influence sponsors to choose particular subsidization, compensation, and user payment mechanisms. A second set of issues concerns the impacts on taxi firms of participation in E&H services. Financial impacts, notably revenues and profitability, are obviously important, but equally significant are potential changes in the internal organization of the firm and in its capabilities, image, and future objectives. The relationship between these impacts and system organization parameters is another key issue. System performance and its determinants is the third major area of analysis. Performance is not only important in its own right, but particularly as it may be affected by system organization. Throughout the analysis the differences between taxi involvement in general public and E&H services will be emphasized, thus illustrating the distinctive organization, impacts, and performance of these two forms of taxi-based paratransit.

II. System Organization

The organization of a taxi-based E&H system encompasses six factors: the decision to restrict ridership (and the severity of the restriction), the decision to use a taxi firm as provider, the determination of whether to use dedicated vehicles or an integrated fleet system, the selection of a subsidization option, the adoption of a provider compensation mechanism, and the choice of a user payment system. In practice, these factors are highly interrelated. A sponsor's decision to restrict ridership and its determination of what the role of the system will be--ranging from basic community public transit to a strictly supplemental service to fixed-route transit for the most mobility impaired individuals--has a major bearing on the feasibility and attractiveness of the other specific system organization parameters. Instead of an infinite variety of systems, the reality is a small number of distinct types, organized in ways which are internally consistent as well as compatible with sponsor objectives, the market situation, and the operating capabilities of the taxi provider.

Restricting Use to the E&H

Over the past several years, sponsors of DRT systems have increasingly opted to restrict eligibility of use, almost invariably as a strategy for containing costs. The sponsors of California's taxi-based E&H systems have been similarly motivated. All but two of the 48 systems faced either absolute funding limitations or serious competition for the funds that were used to subsidize the service.

As indicated in Table 1, the most frequently utilized source of subsidy was a special funding category of California's state transit subsidy program. Article 4.5 of the Transportation Development Act (TDA) provides for up to 5 percent of TDA funds to be used for community transit services in the largest urban counties. These counties, however, are precisely the areas in which fixed-route transit is dominant, so merely obtaining the 5 percent funding for local DRT services has been quite difficult politically. Moreover, even when the full 5 percent is available for community transit, as in the San Francisco Bay Area, it represents a relatively small sum to a city, and by itself is typically inadequate to finance a general public DRT system. Nonetheless, twenty-six of the California systems depend entirely on Article 4.5 funds.

TABLE 1
SOURCE OF SUBSIDY

<u>Source</u>	<u>Number of Systems*</u>
State transit subsidy program, special funds	27
State transit subsidy program, regular funds	13
Municipal general funds	5
Transit agency funds--State and Federal subsidies intermixed	4
Social service program funds	1

*Sums to more than 48 because two systems use multiple sources of subsidy.

Although none of the remaining 22 systems faced such stringent absolute limits on available subsidies, all were funded by sources which could be allocated to competing purposes--streets and roads in the case of the regular TDA funds, other municipal programs in the case of increasingly scarce municipal general funds, and other transit services in the case of transit agency funds. While regular TDA funds can be used for streets and roads in nonmetropolitan areas only if no "unmet transit needs" exist, it has been the common practice in such areas to spend as little as possible on transit and the remainder on highways. Restricting DRT use to the E&H thus preserves most of the TDA funds for the community's highest transportation priority, highway maintenance and construction, while alleviating the plight of those seemingly in greatest need of a transit alternative.

In deciding to restrict DRT ridership, then, public officials were predominantly concerned with the total cost of the system, and not its potential performance or cost-effectiveness. The relative weight given in subsequent system design to the two factors of total cost and cost-effectiveness depended on the stringency of the fiscal constraint, but in every case the former was deemed more important when initial decisions about the system were made. As a result, a political and planning climate has been created (at least in California) in which the elderly and handicapped have policy priority for scarce DRT resources.

Choice of Taxi Firm as Provider

Most of the restricted ridership DRT systems established in California have been designed specifically as taxi-based E&H systems. About 80 percent of all restricted ridership DRT systems in the state utilize a taxi firm as provider, whereas only about half of all general public DRT systems are operated by a taxi company. Of the 48 E&H systems which were the focus of this study, only two had a provider other than a taxi company bid on the system. That is, in 46 of the 48 systems, the only feasible provider was a taxi firm. The two exceptions, moreover, are systems which used dedicated vans and are targeted primarily at the transportationally handicapped. In the large majority of cases there was no competitive bidding. A contract for service was generally negotiated with either the sole local taxi company or all the taxi firms serving the area.

There are several reasons why California's E&H systems have been targeted at and operated by taxi firms. In common with taxi provision of general public DRT, the use of a taxi firm in an E&H system offers the sponsor the advantages of low production costs, in-place capability, and rapid implementation. Moreover, few sponsors of either general public or E&H service wish to incur the difficulty or expense of being in the "transportation business." Using a local firm also provides political advantages; it avoids potential government competition with private firms, and it may insure that taxi service is available to the community by keeping the local taxi firm (or firms) afloat financially. The latter

objective has become increasingly important in many small cities, where conventional taxi service alone often will no longer sustain a company. Finally, the taxi industry in California has been relatively aggressive in pursuing local public transportation opportunities.

Equally significant, many of the E&H systems in California are not suited to cost-effective operation by any provider other than a local taxi company due to their low demand densities. In such situations the traditional Dial-A-Ride form of service organization (dedicated vehicles, provider-side subsidy) leads to high costs per passenger for the sponsor, while if demand is very low a user-side subsidy makes financial sense for the provider only if the E&H operation can be integrated with another transportation service which produces significant revenues. Taxi firms have a large advantage with respect to the latter consideration.

It bears noting that in California various forms of taxi-based transit have become DRT options in and of themselves through a diffusion of innovation process. Many sponsors cited well-known successful experiences with taxi-based DRT as inspiration for using a taxi provider for their system, or simply emulated the features of a neighboring E&H system which seemed to perform satisfactorily. The latter mode of diffusion of taxi-based E&H systems was particularly important in the San Francisco Bay Area, which contains 22 systems, most of them highly similar in organization. Many sponsors in this region did not even consider the possibility of organizing the service differently. It is apparent then that taxi firms have predominated in California's E&H services because this arrangement addresses local political concerns, is

simple for sponsors to implement, and presents a compatible base for the typically low demand E&H systems.

Subsidization, Compensation, and Mode of Operation

California's taxi-based E&H systems are predominantly organized along user-side subsidy principles, whereby a provider receives payment only for consumed service (e.g., passenger trips). As indicated in Table 2, 85 percent of all systems are subsidized in this fashion. Overall, only 25 percent of the E&H systems use dedicated vehicles. Fully 75 percent of the systems are based on the combination of an integrated fleet operation and payment for consumed service, a combination shown to be associated with a high level of cost-effectiveness when taxi vehicles are deployed in a shared-ride mode of operation (3). However, three-fourths of the taxi-based E&H systems in California utilizing this combination of organizational arrangements do not practice shared riding, but instead are ERT operations. In fact, only 22 of the 48 systems included in this study are organized on shared-ride principles; the remainder are simply subsidized ERT systems, most of which use ERT meter fares as the basis for provider compensation. This stands in marked contrast to California's approximately 25 taxi-based general public DRT systems, all of which are shared-ride operations, and most of which use dedicated vehicles.

These distinctive organizational features of taxi-based E&H systems stem primarily from three factors. The first is the very nature of a restricted ridership transportation program. The service concept of an

TABLE 2
 COMPENSATION ARRANGEMENTS AND MODE OF OPERATION
 BY DIFFERENT SUBSIDY AND VEHICLE USE COMBINATIONS

<u>System Organization Arrangement</u>	<u>Number of Systems*</u>
1. User-Side Subsidy, Integrated Fleet Systems	(39)
ERT operations, ERT meter fare compensation	25**
ERT operations, fixed fee compensation	4
SRT operations, fixed fee, zonal fare, or mileage compensation	6
SRT operations, ERT meter fare compensation	4***
2. User-Side Subsidy, Dedicated Vehicle Systems	(5)
SRT operations, fixed fee compensation	5
3. Provider-Side Subsidy, Dedicated Vehicle Systems	(7)
SRT operations, vehicle hour compensation	6
SRT operations, cost-plus compensation	1

* Total sums to more than 48 because three systems use multiple arrangements.

** In several systems meter fares are discounted by 10 percent.

*** In three systems shared riding practiced on only one leg of user round trip, and meter fares are discounted by 25¢.

E&H system is driven by budgetary limitations, and low ridership is inherent in this service concept when such limitations are at all severe. In most such cases, service is not only restricted to the E&H, but is also rationed by strict eligibility standards and limitations on the number of trips which may be taken. Low ridership means very low demand densities compared to general public DRT systems, and it severely constrains the feasible options for organizing the service.

For example, consider the taxi-based DRT systems in Hayward and Fullerton (as Fullerton's system operated in 1978-79--it has subsequently been changed). Each is a suburban California city of about 100,000 population, roughly similar in socioeconomic characteristics, with reasonably good fixed-route transit service. Fullerton had a general public DRT system in which service was provided 10 hours per day. Hayward's system is E&H-only, is available 24 hours per day, and has about 900 persons registered; users are restricted to 10 rides per month with a maximum \$7 meter fare per ride. Ridership was much higher in Fullerton than Hayward, by a factor of five on a passengers per capita basis. The demand density of the Hayward system is about 2.5 trips per square mile per day; in Fullerton the comparable figure was nearly eight times greater. Under these favorable circumstances the Fullerton DRT system achieved a productivity of only 5.5 passengers per vehicle service hour. Given the vastly lower demand densities in Hayward's E&H system, it is apparent that shared riding is virtually infeasible. Not surprisingly, the Hayward system is simply a subsidized ERT service.

The second major factor affecting the choice of system organization parameters is the sponsor's objectives for the E&H systems. In particular, is the service strictly a supplement to fixed-route transit for those who have difficulty using or accessing the bus system, or is it designed to fulfill the basic public transit needs of the elderly and handicapped members of the community? Sponsor objectives are of course heavily influenced by the level of funding available for operating the DRT system. In general, when reasonable amounts are available, sponsors are prone to view the system as basic transit and design accordingly.

As Table 3 indicates, when sponsors are reasonably well endowed financially (as measured by their use of regular TDA funds to support the system) and view the DRT system as basic public transit for the E&H, they are three times more likely to have organized their system along SRT lines than sponsors contending with significant fiscal constraints (as measured by their use of Article 4.5 TDA funds) and viewing their system as a supplementary service.

While both groups of sponsors were concerned with the total cost of the system, the former group did not deem it necessary to constrain demand to keep within an absolute budget ceiling. However, these sponsors did wish to achieve maximum community benefits without using funds unproductively. Most of these sponsors thoroughly investigated their options, and realized that shared riding was an essential component of any cost-effective system design. The latter group of sponsors contended from the outset with a low demand service, and proved

TABLE 3
MODE OF OPERATION BY SPONSOR OBJECTIVES AND MAJOR FUNDING SOURCE

<u>Sponsor Objectives and Major Funding Source</u>	<u>Number of Systems</u>	
	<u>ERT</u>	<u>SRT</u>
1. Supplement to Fixed Route for E&H		
State transit subsidies, special funding	20	6*
State transit subsidies, regular funding	3	0
Municipal general funds	2	2
Transit agency funds	<u>0</u>	<u>1</u>
Subtotal	25	9
2. Basic Public Transit for E&H		
State transit subsidies, special funding	0	1
State transit subsidies, regular funding	<u>3</u>	<u>7</u>
Subtotal	3	8
3. Special Transit Agency Service for Mobility Impaired		
Transit agency funds	<u>0</u>	<u>3</u>
Total	28	20

* In three systems, shared riding practiced only on one leg of user roundtrip.

uncreative in organizing the systems so as to boost productivity. In general, they opted for subsidized ERT as the easy way out of an admittedly difficult DRT situation.

The diffusion of information about other DRT systems in California is the third factor influencing system organization choices by sponsors. Typically lacking any detailed knowledge of paratransit operations, and often unable to afford a consultant to plan the system, most sponsors sought to simplify the task of designing the service by seeking out service models that had achieved good results elsewhere.

Several sponsors desiring a system which could provide basic public transit used the highly successful El Cajon SRT system as their model, thereby organizing their system on the basis of an integrated fleet, shared riding, and compensation for consumed service. Many of the sponsors who organized subsidized ERT systems admitted that they were simply following the lead of a neighboring city, or adopting the general practice for an E&H system in their region. The search for the best system organization scheme for a particular local situation thus tended to be limited except in cases where the sponsor was either unusually knowledgeable or required a cost-effective basic transit system.

User Payment System

Many sponsors of California's taxi-based E&H system devoted at least as much attention to devising a user payment mechanism as they did to such factors as provider compensation and mode of operation. In part, this preoccupation with revenue management is attributable to a state

requirement that at least 10 percent of the total cost of an E&H system must be recovered from the farebox. More importantly, the use of a taxi provider, particularly in the context of user-side subsidies, creates additional options for user fare payment compared to conventional transit. As indicated in Table 4, sponsors have utilized four different methods for recovering revenues from users of the system.

TABLE 4
USER PAYMENT MECHANISM

<u>Mechanism</u>	<u>Number of Systems</u>		
	<u>SRT</u>	<u>ERT</u>	<u>Total</u>
Scrip with discount*	0	15	15
Tickets/Coupons	9	6	15
Tickets with meter limits	1	7	8
Cash Fare	10	0	10

*Cash discount of 50-90% of scrip face value.

There is a strong relationship between system mode of operation (SRT or ERT) and user payment mechanism. Shared ride systems rely either on tickets, which users typically purchase from the sponsor for 50¢ to 75¢, or on cash fares, also generally in the 50-75¢ range. The SRT systems using tickets are predominantly those based on integrated fleet, user-side subsidy arrangements, while the cash fares are used primarily in dedicated vehicle, provider-side subsidy systems. In general, the more complicated ticket mechanism is used instead of cash fares only when

it is an integral part of the provider compensation scheme, that is, when the provider is reimbursed a fixed fee per ticket collected. In such cases, the ticket mechanism enables the sponsor to target subsidy at eligible users, to easily adjust level of subsidy and provider payment, and to insure provider honesty in reimbursement claims. When provider-side subsidy is utilized, however, these benefits are substantially reduced, and sponsors are more sensitive to the administrative costs and inconveniences of ticket schemes.

ERT systems, on the other hand, have made extensive use of scrip payment schemes, while completely shunning cash fares. The scrip system is well-suited to subsidized ERT: it works well with meter fares, is readily converted to cash, and therefore meets little resistance from drivers or owners. Perhaps the main advantage of the scrip system is that it enables sponsors to recover a guaranteed, and usually higher percentage of service costs from the user compared to the other user payment mechanisms. Scrip discounts to the user average 75 percent, and range between 50 and 90 percent. Scrip, like tickets, can be rationed when the E&H system operates under a tight budget. Moreover, another attraction to budget conscious sponsors is that scrip systems contain an inherent disincentive to long, costly ERT trips, since the user is paying a fixed percentage of the actual meter fare. A simple ticket system, in contrast, does not discourage such trips. About half of all sponsors of subsidized ERT systems which use tickets have been forced to adopt a limit on the meter fare for which the ticket is sufficient user payment; additional mileage is paid for solely by the user. The scrip system and

the ticket scheme with a meter fare limit are employed predominantly by the most fiscally constrained sponsors, and they have proven to be effective mechanisms for keeping subsidy requirements within stringent budget limitations.

III. Taxi Firm Impacts

Financial Impacts

Becoming a public transportation provider is a significant development for any taxi firm, but impacts on E&H providers are typically much less significant than on general public DRT (or other public transit) operators. Two readily available impact measures are the number of transit systems (both E&H and general public) in which the taxi company is a provider, and the revenues the firm receives from its transit contracts.

Taxi firms which are primarily E&H providers generally have a lower level of involvement in public transportation operation than general public DRT taxi providers. Just six of the California taxi firms which are E&H-only contractors have multiple exclusive contracts. Sixty percent of the E&H-only providers participate in but a single public transportation operation, whereas 73 percent of the taxi firms which have general public DRT contracts are providers for more than one system. Only 12 percent of all E&H operators have obtained multiple exclusive contracts (the most lucrative type).

Since the size of DRT contracts can vary widely, the amount of revenues the firm receives from contract operations is probably a better

measure of impacts than the number of systems in which it participates. As indicated in Table 5, 29 percent of all E&H providers obtain at least \$100,000 from contract operations, and about 15 percent make \$250,000 or more. However, among providers who participate only in E&H systems, only 22 percent derive \$100,000 or more from contracts, and a mere 5 percent make as much as \$250,000. In contrast, 55 percent of all taxi firms with general public DRT contracts make at least \$250,000 from these operations (see Table 6). These results strongly imply that taxi firms which are E&H-only providers benefit much less financially from their participation in public transportation than do general public DRT providers.

As indicated in Table 5, E&H providers who also operate general public transit systems (DRT or fixed-route) gross approximately \$450,000 annually from their public transportation contracts. For all California taxi firms which are general public DRT providers, average annual contract revenues are about \$360,000. In contrast, firms which operate only E&H systems receive an average of \$76,000 annually from these contracts.

Financial impacts on providers are also significantly affected by system organization factors, in particular whether or not the taxi firm is the operator of a shared-ride system. Providers with at least one shared ride operation obtained on the average more than 2 1/2 times as much contract revenue as did firms which participate only in subsidized ERT systems. Even excluding one provider with an exceptionally large contract, the former group of companies still made an average of nearly twice as much from contracts as did the latter group.

TABLE 5
E&H PROVIDER CONTRACT REVENUES BY TYPE OF CONTRACT OPERATIONS

<u>Contract Revenues</u>	<u>Number of Providers by Type of Contract Operations</u>				
	<u>Provider operates E&H systems only</u>	<u>At least one shared ride system</u>	<u>ERT systems only</u>	<u>Provider Operates E&H and General Public Systems</u>	<u>All Providers</u>
Greater than \$500,000	1	0	0	3	4
\$250,000-500,000	1	0	0	2	3
\$100,000-250,000	3	4	4	0	7
\$50,000-100,000	2	10	10	2	14
\$25,000-50,000	3	6	6	0	9
Less than \$25,000	<u>1</u>	<u>10</u>	<u>10</u>	<u>0</u>	<u>11</u>
All revenue levels	11	30	30	7	48
Mean contract revenues	\$137,400	\$53,000	\$53,000	\$450,000	
	(\$100,500)*			(approximate)	
Mean contract revenues per vehicle	\$ 11,350	\$ 4,500	\$ 4,500	\$ 22,600	

*Excludes one disproportionately large contract.

TABLE 6
 CONTRACT REVENUES FOR PROVIDERS OF GENERAL PUBLIC DRT SYSTEMS

Number of Providers with Indicated Level of Revenues From:

<u>Contract Revenues</u>	General public systems only	E&H Systems only	All contract operations
Greater than \$500,000	2	0	3
\$250,000-500,000	4	1	3
\$100,000-250,000	0	1	0
\$50,000-100,000	2	1	2
Less than \$50,000	3	2	3

Another measure of E&H contract impacts on taxi firms is the relative contribution of contracts to the firm's revenue base. This should be assessed in terms of contract dollars vs. regular taxi revenues. About 40 percent of the companies involved in E&H services make use of owner-driver relationships and the management of these firms were therefore unable to provide overall fare revenues, since they simply did not know how much total revenue the operation generated.

As this information was unavailable, fleet size was used as a proxy for the firm's potential to generate ERT revenues. Revenue generating potential was measured in each category by comparing contract dollars to the number of vehicles (Table 5). This comparison indicates that relative to the potential for generating ERT revenues (vehicles) the affects of system organization are similar to the trends noted

previously. That is, shared ride operations and general public DRT contracts are associated with more revenue per vehicle. Of course, firms operating in different environments (e.g., central cities vs. small towns) can generate significantly different amounts of ERT revenue per vehicle. The practical effect is to reduce the importance of E&H contract revenues (relative to mean values) in central cities and increase the impact in small towns. However, companies located in small cities in non-urbanized areas or in suburban areas were far more likely to have multiple contracts, to do shared riding, or to operate general public DRT systems than their central city counterparts. In addition, whatever the operating environment, the E&H-only providers usually have a single contract, whereas the general public DRT operators tend to obtain more than one. These considerations all support the conclusion that E&H-only providers are much less favorably impacted financially than those taxi firms involved in paratransit operations for the general public.

The picture which emerges is that of a majority of E&H providers with only limited participation in and limited benefits from public transportation, and of a minority of firms which have been impacted substantially and favorably through more extensive involvement in transit operations. The former group is typically involved in only a single E&H system and has no other transit contracts. The latter firms' involvement in public transportation usually includes some combination of multiple exclusive E&H contracts, shared-ride E&H service, and other community transit operations.

System Organization and Taxi Company Evolution

Becoming the provider of a shared-ride E&H system has a major influence on taxi firm evolution. As noted previously, firms with at least one such contract receive significantly more revenues than subsidized ERT providers. Not only are SRT systems typically more lucrative than ERT contracts, but the firm is required to change at least some features of its operation in order to perform shared riding effectively and accommodate a new compensation scheme. Sponsors of SRT systems, moreover, tend to have higher expectations about performance than do sponsors of subsidized ERT. This creates new responsibilities and challenges for management, whereas subsidized ERT is largely business as usual. The result is an opportunity to upgrade the company's capabilities, to become more than a conventional taxi operation at limited cost and risk to the firm. Having accomplished this, management is in a position to obtain other new sources of revenues. Additional public transit operations are among the most promising opportunities for such further diversification.

Involvement in a subsidized ERT system, in contrast, carries neither the motivation nor the opportunity for company evolution. Of the 34 firms which provide subsidized ERT service, only two are also the providers for a shared-ride system in which the operator is responsible for accomplishing the shared riding, and in one case this is a one-vehicle operation. Only five of these firms have multiple exclusive transit contracts of any type. While welcoming the added revenue of the subsidized E&H program, most operators have not viewed this development

as an opportunity or a reason to change the company's capabilities or image. Out of over 40 firms involved only in E&H services, just one has been transformed into a diversified paratransit operation.

Perhaps the most telling indication of the differences between the firms which provide shared-ride services and those which operate only subsidized ERT services is how they have reacted to the financial difficulties besetting the taxi industry. The SRT providers have adopted a strategy of revenue expansion, attempting to obtain public transportation contracts to improve profitability in light of the decline in ERT revenues. On the other hand, with few exceptions the managers of the ERT-only providers have attempted to cope by reducing their operating costs, and the most popular strategy for accomplishing this has been to make the transition from employee drivers to owner-drivers and/or lease drivers. This is a national trend among taxi companies; however, it does little to attack the root causes of the problem, namely inadequate revenue opportunities. In fact, by diluting management concern about the overall operation revenues (as opposed to fees received by management), it may reduce the potential for more creative action. In addition, the loss of control over drivers makes participation in shared-ride systems (where tight dispatch control is essential for productivity) difficult or impossible.

The internal organization of the taxi firm thus affects a sponsor's ability to employ certain system organization options. For example, if an association of independent owner-drivers is to be a participant in the system, the sponsor cannot organize a shared-ride system. As a result of

internal organizational characteristics the owner-drivers cannot be compelled to follow dispatch directions, and without strict dispatch control shared riding is virtually infeasible. Further, since everyone works for themselves, an association has little incentive to hire drivers to work in a dedicated vehicle system. Some companies comprised of independent owner-drivers have had difficulty functioning effectively in a subsidized ERT system due to the problems of driver turn-downs and ineffective management. One such company in Northern California recently lost a contract for precisely these reasons, and other sponsors have become disenchanted with the performance of owner-driver companies. Although the trend away from employee drivers may temporarily stabilize profits, an exclusively driver-owner situation creates major problems in organizing a responsive, cost-effective E&H service, and thus may be an inappropriate management strategy in a longer term perspective.

IV. System Performance and Its Determinants

The organizational and service delivery characteristics of taxi-based E&H systems make it extremely difficult to carry out a comprehensive performance analysis. As stated previously, many system sponsors are less concerned with performance (cost-effectiveness) than with total costs. Moreover, many E&H systems, particularly those which operate as ERT systems, do not provide sponsors with any but the most basic data, while for integrated fleet systems it is difficult to separate out E&H service costs. Consequently, the performance analysis was limited both in terms of the number of systems evaluated and the aspects of performance

measured. Three performance indicators were selected: (1) total cost (both operating and administrative) per passenger (cost-effectiveness); (2) fare revenue per passenger (consumption effectiveness); and (3) the ratio of fare revenue to total cost (consumption effectiveness).

Cost Effectiveness

Taxi-based E&H services are a relatively expensive form of public transportation. As indicated in Table 7, the average total cost per passenger was \$4.18. In contrast, taxi-based general public DRT services had an average total cost per passenger of \$2.84, based on data collected two years previously (1). Inflating this latter figure by 20 percent to account for increased operating costs during the past two years results in an estimated average total cost of \$3.40 per passenger for comparison purposes. Thus the E&H systems register average costs per passenger nearly 25 percent greater than the estimated costs for the general public DRT systems. These higher costs reflect both the lower productivity of E&H systems, which stem from the inherently lower demand densities, and the fact that the sponsors of over half of the systems do not organize the operation on shared-ride principles. It is thus apparent that sponsors of taxi-based E&H systems are paying a significant cost-effectiveness penalty for the ability to restrict ridership and hold down total system costs.

As Table 7 reveals, the cost-effectiveness of taxi-based E&H transportation varies widely among different types of systems. Although the number of systems in each category is too few to permit meaningful

TABLE 7
COST-EFFECTIVENESS BY TYPE OF E&H SYSTEM

<u>System Organization Characteristics</u>	<u>Total cost per passenger*</u>	<u>Number of Systems</u>
1. Dedicated vehicles, shared-ride operations:		
a. Provider-side subsidy, vehicle hour compensation	\$4.97	5
b. User-side subsidy, fixed fee compensation	3.74	4
2. Integrated fleet, shared-ride operations:		
a. User-side subsidy, fixed fee compensation	2.42	3
b. User-side subsidy, meter fare compensation**	5.81	3
3. Integrated fleet, ERT operations		
a. User-side subsidy, meter fare compensation	4.38	19
b. User-side subsidy, fixed fee compensation	2.35	3
All Systems	4.18	37

*Unweighted average for each category

**Two systems practice shared riding on only one leg of user roundtrip.

statistical analysis of the data, and factors other than system organization almost surely have some effect on the outcomes, the results clearly suggest a relationship between system organization and cost-effectiveness. In particular, the most expensive systems are those using meter fare as the basis for provider compensation or organized along dedicated vehicle, provider-side subsidy lines. In other words, the two conventional ways of organizing a demand responsive service-- either as a traditional Dial-A-Ride system or as a regular taxi operation (ERT service)--are precisely the least cost-effective forms of taxi-based E&H public transportation.

The reasons for the relatively poor cost-effectiveness of these two types of systems are not hard to discern. For a dedicated vehicle, provider-side subsidy system, cost-effectiveness is a function of demand density, the effective speed of the vehicles, and the operator's dispatching capabilities. All of these in turn determine system productivity, the key variable influencing cost-effectiveness when operating costs are relatively constant. In an E&H system, however, productivity is reduced because of low demand density and lower effective speed (passengers require more special treatment). Moreover, three of the five systems in this category are targeted at the transportationally handicapped and serve large areas, further reducing productivity. With the provider's guaranteed hourly reimbursement spread among a very few passengers per hour, such inherently low productivity systems cannot help but register high costs per passenger. On the other hand, the one system in this category which served a medium size city with a predominantly

elderly market achieved a cost per passenger 40 percent lower than the \$4.97 average figure.

Under appropriate circumstances DRT systems organized via the traditional Dial-A-Ride model can achieve high productivities. However, E&H systems organized on ERT principles (i.e., no shared riding, meter fares) are inherently high cost operations. Even though the provider is paid only for consumed service, the low productivity of conventional taxicab operations creates a need for ERT fares to be relatively high. Several providers of subsidized ERT service give their sponsor a discount (never more than 10 percent) from the actual meter fare, but this obviously has little offsetting influence on the overall levels of cost for this type of system.

The high costs of ERT type services also include a significant administrative cost component, on the order of 20-25 percent of total system costs. While only a handful of the subsidized ERT systems spend large absolute dollar amounts on administration, virtually all must allocate a significant proportion of money to this activity due to the requirements of certifying and checking user eligibility, selling scrip or tickets and insuring that a limited budget is not exceeded, all integral aspects of this type of E&H system. Given the low operating budget of many of these systems, the result is a relatively high percentage of administrative expenses.

In general, the most cost-effective way of organizing an E&H system is to establish a shared-ride service and compensate the provider on the

basis of consumed service units. Table 8 indicates how the cost-effectiveness of this type of system compares to both subsidized ERT and the Dial-A-Ride mode of organization.* The cost-effectiveness superiority of such systems--nearly one-third lower costs--is an expected result. It is consistent with previous findings for taxi-based general public DRT systems, which demonstrated that an integrated fleet SRT system with consumed service payment was considerably more cost-effective than the Dial-A-Ride form of system organization (1). The very purpose of shared riding is to achieve the highest possible productivity, and the use of consumed service compensation gives the operator a compelling incentive to be as productive as possible.

TABLE 8
COMPARATIVE COST-EFFECTIVENESS OF MAJOR TYPES OF E&H SYSTEMS

<u>System Organization Characteristics</u>	<u>Total cost per passenger</u>	
User-side subsidy, SRT operators, fixed fee compensation	\$3.17	N = 7
User-side subsidy, ERT operations, meter fare compensation*	4.64	N = 21
Provider-side subsidy, dedicated vehicles, vehicle hour compensation	4.97	N = 5

*Includes two nominally shared-ride systems in which most service is in fact ERT.

*Not included in the cost-effectiveness comparison are the ERT systems using a fixed fee compensation scheme. The apparent cost-effectiveness of fixed fee arrangements are misleading, as the length of the trip that is subsidized is limited. Since no data are available on how much users may pay in addition to the ticket (and therefore how much the trip actually costs), cost-effectiveness cannot be evaluated.

It is noteworthy that this type of system is also feasible though somewhat more expensive with dedicated vehicles. The provider of a dedicated vehicle operation must insure that the fee per service unit (typically a delivered passenger or group of passengers) covers the total costs of vehicle operation, as vehicles cannot be used for other purposes. An integrated fleet operator, however, can potentially use otherwise unproductive vehicle time for non-transit services, thus reducing the revenue required from the sponsor of the E&H system.

Consumption Effectiveness

Taxi-based E&H systems have been relatively expensive forms of local public transportation, but they have managed to provide a service which apparently is highly valued among potential users, assuming that willingness to pay is an indicator. Table 9 demonstrates that these

TABLE 9
FARE REVENUE EFFECTS OF DIFFERENT USER PAYMENT MECHANISMS

<u>Mechanism</u>	<u>Fare Revenue Per Passenger*</u>	<u>Fare Revenue/ Total Cost*</u>	<u>Number of Systems</u>
Scrip with discount	\$1.22	28.5%	13
Tickets	.84	18.6	12
Tickets with meter limit	.54	20.4	7
Cash	.54	11.1	7
All systems	.86	20.9	39

*Unweighted average for all systems in each category.

systems have been able to charge relatively high fares, averaging about \$.85, and in the process have recovered about 20 percent of total costs from user revenues. Considering that eligible users are often on restricted incomes and that lower priced conventional transit is also available in many areas, these results would seem to confirm once again that people will pay for good transportation service. (Only a small percentage of users are so handicapped that they physically could not use fixed route transit.)

Further evidence that this is the case comes from a survey taken of the users of Vallejo's subsidized ERT system, which is essentially open to the entire elderly and handicapped community. This is a scrip system in which the discount is only 50 percent. The users, 90 percent of whom have an annual income of less than \$12,000, are nonetheless frequently willing to pay an average cost of over \$1.50 per trip to use the service. Eighty percent use the taxi system at least once a week, and 40 percent use it every other day or more often. Given a choice between the half-fare taxi and a fully accessible bus system, only 25 percent indicated they would switch to the much less expensive bus service.

Table 9 also indicates a definite association between the user payment mechanism and the fare revenues obtained from the user. Scrip systems are by far the most effective both in generating revenue and covering operating costs. Scrip is invariably used in conjunction with a subsidized ERT system, an expensive service to begin with, but the scrip discount is never more than 80 percent, and often less. The sponsors of systems using scrip are typically very budget conscious, and are quite

willing to reduce the discount if budgetary problems are anticipated. Cash fares are employed by systems with the least fare recovery concerns. Generally these systems are organized on traditional Dial-A-Ride principles.

V. Conclusions

During the past several years, taxi firms have emerged as the principle providers of DRT service for the elderly and handicapped in California. The proliferation of taxi-based E&H systems has occurred not only because taxi firms have a cost advantage over other potential providers, but also because they are uniquely well-suited to the requirements of a restricted ridership DRT system. The low demand prevailing in many such systems makes the traditional Dial-A-Ride form of organization either infeasible or overly expensive. The easiest and possibly most cost-effective strategy for sponsors in such cases may be to simply subsidize ERT service for the eligible population. When both demand and the sponsor's budget are sufficient to support a shared-ride system, many E&H sponsors have used the El Cajon SRT system, in which the taxi firm is compensated for consumed service and uses its vehicles interchangeably for SRT and ERT, as their inspiration for service design.

Nearly 50 taxi firms are currently involved in restricted ridership DRT systems in California, but the number experiencing substantial favorable impacts is much less. Although a handful of companies have benefitted significantly from a single subsidized ERT contract, the largest benefits have typically accrued to firms which are involved in

shared-ride E&H operations, provide service for a general public DRT system, and possess multiple public transportation contracts.

Significant impacts from public transportation involvement are particularly a function of the provision of shared-ride services. Not only do SRT providers receive more revenue than those firms which provide only subsidized ERT service, but many are also engaged in a diversification process which has improved their overall capabilities and established them as a competent paratransit contractor. In contrast, companies whose only contracts are for subsidized ERT services remain as conventional taxi operators, non-innovative and heavily dependent on a single type of service which has steadily experienced a market shrinkage. While subsidized ERT has short run benefits for these firms, it may not be a long run solution to the problem of ERT decline.

Shared ride operations are also the key to cost-effective organization of an E&H system. The most cost-effective method of organizing most E&H service is through the El Cajon model--a single provider, shared riding, user-side subsidies, and an integrated fleet. Subsidized ERT is more expensive service, but it is probably the only feasible strategy in situations of very low demand where the sponsor faces a severe total cost constraint. Overall, taxi-based E&H services are at least 25 percent more expensive than taxi-based general public DRT, because the systems typically cannot be as productive due to the lower demand densities.

We are thus left with the central dilemma of taxi-based E&H services. Shared ride operation is the key to good system performance, the most

favorable financial impacts, and the initiation of the taxi provider's evolution toward a paratransit contractor; it therefore should be employed whenever possible. However, restricting use of the service to the E&H in response to financial constraints results in low service demand, an impediment to shared riding. On the other hand, low demand is the factor which makes the local taxi firm such an appropriate choice of provider for many E&H programs. If California's experiences are representative, taxi-based forms of service are the wave of the future in E&H transportation. The issues now are how to improve the cost-effectiveness of these services, and how to organize and use them to foster long-lasting beneficial impacts for participating taxi firms.

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