

If the taxi industry is to extricate itself from its current financial situation, two forms of public action will be required. First, taxi ordinances must be updated to reflect current operating realities. Included in that update would be provisions that allow taxis to offer a broader range of services to a larger market segment and quicker recovery of costs and greater flexibility in the pricing of services. If prices must be regulated, then those regulations should distribute the risk of the fixed price equally between the company or operator and drivers.

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Taxi-Based Public Transportation for the Elderly and the Handicapped

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The system organization, performance, and taxi firm impacts of California's taxi-based elderly and handicapped (E&H) systems are analyzed, and the results are compared with taxi-based general-public demand-responsive transportation (DRT) systems. The data were gathered from 48 California taxi-based E&H systems. Sponsors have restricted ridership to the elderly and the handicapped due to budgetary constraints and, when such constraints are severe, they have also rationed service among this group. The low demand services that often result are ideally suited to provision by taxi firms, as they can be integrated with other taxi services. In many cases demand is so restricted that sponsors simply subsidize regular taxi service, as shared riding is difficult or infeasible. Due to the prevalence of such subsidized exclusive-ride taxi (ERT) services, E&H systems are considerably less cost effective than taxi-based general-public DRT. E&H services have been organized in essentially three ways: as traditional dial-a-ride operations, as subsidized ERT service, or as user-side subsidy shared-ride taxi (SRT) service. SRT has proved to be the key to superior performance. In general, shared-ride operations result in high levels of performance, provide the most favorable taxi firm financial impacts, and initiate the company into the paratransit diversification process. In situations where the sponsor faces a severe total cost constraint, however, organizing a subsidized ERT system is probably the only feasible strategy. Subsidized ERT systems are about 40 percent more expensive than user-side subsidy SRT systems, have less impact on company revenues, and do little to enhance taxi firm evolution.

Two trends have dominated the recent diffusion of demand-responsive transportation (DRT) services. The first 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 trend 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 the handicapped. In a number of

communities around the country, these two developments have coincided, which results in the establishment of a generation of taxi-based restricted-ridership DRT systems, typically targeted at elderly and handicapped individuals. California alone contains nearly 50 such public transportation systems.

Taxi-based DRT systems for the elderly and the handicapped 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 the provider has a significant effect on system organization and performance. Restricting use to the elderly and the handicapped reduces demand well below the levels achieved by general-public DRT systems, in which the elderly and the handicapped typically comprise about 25-50 percent of the passengers. In addition, many sponsors impose restrictions within this category, thereby further decreasing potential demand. The resulting low demand density limits the ability of the provider to practice shared riding and often renders 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 that often use vehicles dedicated solely to the DRT system, many taxi-based elderly and handicapped (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 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 subjected 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, which are quite possibly the most rapidly growing component of taxi-based paratransit.

This analysis is based on the results of a study of 48 taxi-based E&H systems in California, which comprise essentially all such systems currently operating in the state. Data were collected on the operating and financial performance of these systems for the 1979-1980 and/or 1980-1981 fiscal years. Information was also obtained via personal interviews with sponsors and providers on the process leading to the establishment of these systems, the impacts on the involved taxi firms from participation in public transportation, and the nature and evolution of the relation between the public and private sectors. These California systems not only represent the largest single data base available for analysis of taxi-based E&H services, but 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: (a) system organization, (b) impacts on taxi firms, and (c) system performance and its determinants. 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.

SYSTEM ORGANIZATION

The organization of a taxi-based E&H system encompasses six factors:

1. Decision to restrict ridership and the severity of the restriction,
2. Decision to use a taxi firm as provider,
3. Determination of whether to use dedicated vehicles or an integrated fleet system,
4. Selection of a subsidization option,
5. Adoption of a provider compensation mechanism, and
6. 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 and highly restricted service--have 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 that are organized in ways that 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 Elderly and the Handicapped

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 2 of the 48 systems faced either absolute funding limitations or serious competition for the funds that were used to subsidize the service.

The most frequently used source of subsidy for taxi-based E&H service is 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; thus, 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. Therefore, in the 26 systems that depend entirely on Article 4.5 funds for subsidies, there is strong pressure to restrict use to the elderly and the handicapped.

Although none of the remaining 22 systems faced such stringent absolute limits on available subsidies, all were funded by sources that could be allocated to competing purposes, i.e., streets and roads in the case of regular TDA subsidies, other municipal programs in the case of increasingly scarce municipal general funds, and other transit services in the case of transit agency funds. Although 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 elderly and the handicapped 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 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 the 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 use 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 that were the focus of this study, only 2 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 that used dedicated vans and are targeted primarily at the transportation handicapped. In a 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 that serve 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 ensure 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 subsidy costs per passenger for the sponsor, whereas if demand is very low a user-side subsidy scheme makes financial sense for the provider only if the E&H operation can be integrated with another transportation service that produces significant revenues. Due to their operation of regular ERT services in the same area as the E&H service, taxi firms have a large advantage over other providers with respect to the latter consideration.

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 1, 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 that use 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 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 that the rationale for restricting DRT use to the elderly and the handicapped derives directly from budgetary limitations, and low ridership is the inevitable consequence when such limitations are at all severe. In most such cases, service is not only restricted to the elderly and the handicapped, but it is also rationed by strict eligibility standards and limitations on the number of trips that may be taken. Low ridership means very low demand densities compared with general-public DRT systems, and it severely constrains the feasible options for organizing the service.

For example, the demand density for general-public DRT systems in California ranges from 5 to 50 passengers/mile²/day; taxi-based systems average about 16 passengers/mile²/day. In contrast, overall demand density for E&H systems is about 6 passengers/mile²/day and much less for many systems that ration service. For example, consider two roughly comparable communities, Hayward and Fullerton, the former having an E&H system for which service is rationed and the latter a general-public DRT system. Demand density in Fullerton was nearly eight times greater than that in Hayward. Even so, the Fullerton system achieved a vehicle productivity of about 5.5 passengers/vehicle service hour, which is reasonable but not outstanding for DRT. Given the much lower demand density in Hayward, it is apparent that shared riding is virtually infeasible. Not surprisingly, this system is simply a subsidized ERT service.

The second major factor that affects the choice of system organization parameters is the sponsor's objective for the E&H service. These objectives are heavily influenced by the level of funding available. When funds are restricted, sponsors typically view DRT as a supplemental service to fixed-route transit for those elderly and handicapped people who have difficulty using or accessing the bus system. In contrast, when there is no stringent limitation on subsidy availability, sponsors are prone to view the DRT service as basic public transit for the elderly and the handicapped members of the community. The latter group of sponsors was three times more likely to organize the E&H system along SRT lines than those sponsors that had to contend with severe financial constraints and thus designed a supplemental service. Although both groups of sponsors were concerned with the total cost of the E&H system, those who opted for a basic public transit system did not deem demand restrictions necessary in order to keep within an absolute budget ceiling and were thus able to give higher priority to cost-effectiveness considerations in designing the system. Most of these sponsors thoroughly investigated their options and realized that shared riding was an essential component of any cost-effective system. The other group of sponsors largely opted for subsidized ERT service and viewed cost-effectiveness as a secondary objective for their supplemental E&H systems if it meant additional funds or administrative effort had to be committed to the service to make shared riding feasible.

The diffusion of information about other DRT systems in California is the third factor that influences 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 that desired a system that 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.

Table 1. Compensation arrangements and mode of operation by different subsidy and vehicle use combinations.

System Organization Arrangement	No. of Systems ^a
User-side subsidy, integrated fleet systems	
ERT operations, ERT meter-fare compensation	25 ^b
ERT operations, fixed-fee compensation	4
SRT operations, fixed-fee, zonal-fare, or mileage compensation	5
SRT operations, ERT meter-fare compensation	5 ^c
User-side subsidy, dedicated vehicle systems	
SRT operations, fixed-fee compensation	5
Provider-side subsidy, dedicated vehicle systems	
SRT operations, vehicle-hour compensation	6
SRT operations, cost plus compensation	1

^aTotal sums to more than 48 because 3 systems use multiple arrangements.
^bIn several systems meter fares are discounted by 10 percent.
^cIn three systems shared riding practiced on only one leg of user round trip and meter fares are discounted by \$0.25.

User Payment System

Many sponsors of California's taxi-based E&H systems 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 with conventional transit. As indicated in the table below, sponsors have used four different methods for recovering revenues from users of the system (note that for scrip with discount that it is a cash discount of 50-90 percent of scrip face value):

Mechanism	No. of Systems		
	SRT	ERT	Total
Scrip with discount	0	15	15
Tickets or coupons	9	6	15
Tickets with meter limits	1	7	8
Cash fare	10	0	10

There is a strong relation 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 \$0.50 or \$0.75, or on cash fares, which are also generally in the \$0.50-\$0.75 range. The SRT systems that use 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 the level of subsidy and provider payment, and to ensure provider honesty in reimbursement claims. When provider-side subsidy is used, 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 with other 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 and 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 that 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 proved to be effective mechanisms for keeping subsidy requirements within stringent budget limitations.

TAXI FIRM IMPACTS

Financial Impacts

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

Taxi firms that are primarily E&H service providers generally have a lower level of involvement in public transportation operations than general-public DRT taxi providers. Only 4 of the 41 California taxi firms that are E&H-only service contractors have obtained multiple exclusive contracts for public transportation services. Sixty percent of the E&H-only service providers participate in but a single public transportation operation, whereas 73 percent of the taxi firms that have general-public DRT contracts are providers for more than one system.

Because 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 Tables 2 and 3, 29 percent of all E&H service 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.

Those E&H service providers who also operate general-public transit systems (DRT or fixed-route) gross approximately \$510 000 annually from their public transportation contracts. For all California taxi firms that are general-public DRT providers, average annual contract revenues are about \$390 000. In contrast, firms that operate only E&H systems receive an average of \$76 000 annually from these contracts. Thus, E&H-only service providers make an average of only 15 to 20 percent as much from public transit contracts as do their more widely diversified counterparts.

Financial impacts on providers are also significantly affected by system organization factors, particularly whether or not the taxi firm is the op-

achieve high productivities. However, subsidized ERT systems are almost always high-cost services. Even though the provider is paid only for consumed service, the low productivity of conventional taxi-cab operations creates a need for ERT fares to be relatively high. Only when trip lengths are short (1.5 miles or less) can subsidized ERT compete with the cost-effectiveness of user-side subsidy SRT systems. The high costs of ERT-type services also include a significant administrative cost component, nearly \$1.25/passenger, or more than 20 percent of total system costs for the majority of systems. Although only a handful of the subsidized ERT systems spend large absolute dollar amounts on administration, virtually all must allocate a significant proportion of total program funds to this activity due to the requirements of certifying and checking user eligibility, selling scrip or tickets, and ensuring that a limited budget is not exceeded--all of which are integral aspects of this type of E&H system.

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. The cost-effectiveness superiority of such systems--about 40 percent--is an expected result. It is consistent with previous findings for taxi-based general-public DRT systems, which have 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. It bears emphasis that the absence of restrictions on elderly and handicapped use of these systems is an important reason that they were able to achieve levels of productivity that kept costs per passenger low. With utilization rates 3 to 6 times those of the other types of service, demand density was at a level where shared riding was easily accomplished. In addition, the combination of relatively high ridership and lack of stringent use restrictions reduces administrative burden, both relatively and absolutely.

CONCLUSIONS

During the past several years, taxi firms have emerged as the principle providers of DRT service for the elderly and the 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 DRT organization either infeasible or overly expensive. Integrating the E&H service with the local taxi firm's other services by using either shared riding or exclusive riding is usually a simpler and relatively less-expensive way of providing the desired service.

Almost 50 taxi firms are currently involved in restricted-ridership DRT systems in California, but the number that experiences 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 that are involved in shared-ride E&H service 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 that provide only subsidized ERT service, but many are also engaged in a diversification process that has improved their overall capabilities and established them as competent paratransit contractors. In contrast, companies whose only contracts are for subsidized ERT services typically remain as conventional taxi operators, noninnovative and heavily dependent on a single type of service that has steadily experienced a market shrinkage. Although 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 many E&H services is through the El Cajon model--a single provider, shared riding, user-side subsidies, and an integrated fleet. Subsidized ERT is a significantly 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 about 30 percent more expensive than taxi-based general-public DRT.

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 elderly and the handicapped in response to financial constraints results in low service demand, which is an impediment to shared riding. On the other hand, low demand is the factor that makes the local taxi firm such an appropriate choice of provider for many E&H service programs. If California's experiences are representative, taxi-based forms of service are the wave of the future in transportation for the elderly and the handicapped. 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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