subsidies are allocated in a manner that bears some resemblance to competitive bidding.

If there is any canon of public administration that has withstood the test of time, it is the merit of competitive bidding as a means of service procurement. The status of most transit properties as the designated recipient of federal and state operating subsidies violates this principle of public finance and gives programming and budgeting powers to the member of the system with the least ability to work around the burdensome constraints of established work rules and the cost of full-time labor.

For many reasons, transit properties have been reluctant to subcontract peak-hour service, purchase service from taxi companies, or cope with the problems associated with negotiating contracts that permit hiring part-time personnel. Nor have they been eager to complicate maintenance management and personnel deployment by developing specialized services to accommodate localized or specialized needs.

The technology biases of transit operating agencies and their inability to circumvent the fixed costs associated with established work rules both argue for locating greater programming authority with regional planning agencies or general purpose government. Where this has been accomplished, in Chicago and San Francisco, planning has been redefined as service procurement and at least limited gains have been made in treating subsidy-allocation decisions as a competitive bidding process. Neither region has seriously solicited claims from unconventional service vendors, but an institutional apparatus that would accommodate competition between vendors is in place. The most important element of this institutional apparatus is the discretion to allocate state and federal operating-assistance funds among competing claimants. In practice, this discretion has been sharply limited by the rapid escalation of operating losses and the imperative of keeping the buses running.

As these agencies—the Chicago Regional Transportation Authority and the San Francisco Metropolitan Transportation Commission—mature, both politically and analytically, one can hope that they will be able to make de facto use of the discretion they already possess in the de jure sense. This will mean distinguishing between the imperative of keeping the buses running and the policy of moving people at a reasonable cost. If there is any hope of distinguishing between means and ends, between running buses and moving people, it lies with planning agencies and general purpose governments, not with agencies committed to a particular technology. And, I would argue, if there is any hope of restraining costs, it lies in the procedure of service procurement through competitive bidding.

None of these thoughts deals with the problem of fair-share politics and the disperson of funds in a way that encourages transit service in markets where it is unlikely to attract significant ridership. Here, too, there is at least limited promise in awarding designated recipient status to a nonoperating agency. This would permit local jurisdictions to use their fair-share entitlement to procure services designed for their specialized needs. This could well mean contracting with a transit property for service, which is an appropriate course of action if it is the result of a search among alternatives and not the only option available. In short, it is time for transit to compete. There are good reasons why transit should not be expected to compete on the terms of the marketplace. But there is no good reason why it should not be asked to compete in terms of cost and service quality with less conventional forms of public transportation.

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# Costs and Productivities of Innovative Urban Transportation Services

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**The aspects of supply and demand that determine the costs and productivities of paratransit services are described, the variations in performance of the services are explained, and ways of improving them are suggested. Publicly owned dial-a-ride services are observed to be very expensive operations and, although the potential for cost reduction exists, these trip costs will probably remain high. The current practices of ubiquitous dial-a-ride services and extremely low fares are questioned. It is also suggested that increased participation in paratransit operations by the private sector—the taxi industry—promises significant improvements in the cost performance.**

Productivity and costs are critical aspects of paratransit operations. They determine the financial viability and economic success of these innovative urban transportation services, and improvements in them will be important determinants of wide-scale success of these operations. This paper discusses the factors that affect these costs and productivities and suggests possible ways of improving them. Costs are affected by the ownership and organization of the providers, the level and type of service, the local regulatory environment, existing labor agreements, and vehicle characteristics. Productivities are determined by the ability of the service to attract

ridership, the nature of the market served, demand density, level of service, and fare structure. The purpose of this paper is to identify the manner in which these aspects of supply and demand affect costs and productivities, to summarize the costs and productivities of some existing operations, and to develop strategies for potential improvements.

The paper is organized in the following manner:

1. The various innovative services are defined and categorized. This classification of the services and the markets in which they operate sets the stage for the comparison of costs and productivities. It is emphasized that comparisons across different markets are not very useful in developing suggestions for improvements in costs and productivities, but that comparisons among different services within a particular market are important. It is suggested that from the standpoint of understanding costs it may be preferable to classify paratransit services from the perspective of their organizational and operating structures rather than by their usual generic distinctions.
2. The second section of the paper summarizes the costs of the common paratransit operations providing service for different travel markets. Variations among the different services and ranges within a particular service and the causes of these variations are discussed and possible ways of decreasing costs are suggested.
3. The third section discusses the productivities of different operations and probable causes of variations. Potential ways of increasing vehicle productivities and ridership are described.
4. The fourth section combines the costs and productivities given in the preceding two sections and presents derivations of the cost per trip for different operations. The interrelations among fares, demand, quality of service, and trip costs; their collective influence on net costs; and the need for financing the deficits are discussed, and the potential for decreasing the cost per trip is considered.
5. The final section summarizes the implications of costs and productivities for future policy and identifies major topics for discussion.

The data presented in this paper are of different vintages. The costs and productivities of the existing operations have been collected from secondary sources (1, 2, 3, and others) that contain information for different systems at different times. However, the numbers are generally compatible. Also, because most of the data are empirical, some existing operations might conceivably fall outside the ranges shown. Another problem arises because most of the data are for relatively new systems that are probably still in the process of learning and adjustment. Thus, to the extent possible, hypothetical numbers—which would perhaps exist after the initial shakedown period—have also been discussed.

## SERVICES AND MARKETS

### Family of Services

The services of interest are the paratransit operations that commonly provide greater route and schedule flexibilities when compared with conventional fixed-route bus services. Thus, they are inherently more responsive to the needs of the potential markets. These service concepts, their supply-and-demand characteristics, and their operating environments are described elsewhere (1, 2, 3).

Prearranged ride-sharing services (car and van pools and subscription buses) and hail-or-telephone services (dial-a-ride, taxi, and jitney) are the most common service innovations. They represent a diverse set of operations providing a wide range in quality of service at different locations in a variety of travel markets. They use different vehicle technologies and operate under diverse organizational and institutional arrangements. Dial-a-ride services are widespread. Typically, they are publicly organized and operated and provide door-to-door areawide service. They operate in different markets (low-density, off-peak travel, and line-haul feeder). Some provide many-to-many services, while others provide more limited services. Many of these operations are 10- to 12-passenger vans, but some use 20- to 30-passenger buses. There are also some taxi-based, shared-ride operations that provide dial-a-ride service. These are privately owned, use standard automobiles, and often operate in a less stringent institutional environment typified by a weaker regulatory framework and a more flexible labor supply situation. Ride sharing and pooled services may use standard automobiles (car pools), vans (van pools), or buses (subscription buses). In the latter two categories, the level of service often varies according to the type and size of vehicle and the route-access characteristics.

In addition to dial-a-ride, taxi, and group-riding (pooled) services, there are other concepts such as jitneys (legal and illegal) and route-deviation services. However, these are not common, and data are scarce. They will not be discussed in depth in this paper. These services are generally thought to provide some flexibility in routing and scheduling and probably fall somewhere between a conventional bus and the more common paratransit services. Although experience in the United States has been limited, many believe that jitneys could readily serve many of the markets being served by more common paratransit operations today. If the cost structures and efficiencies of the existing jitneys (such as the legal fixed-route services in San Francisco and Atlantic City, New Jersey, and the illegal operations in Pittsburgh, Chicago, and other places) could be sustained, they could provide strong competition for many of the other paratransit operations. Again, however, the data are insufficient. It is difficult to speculate on what might happen to the low costs and high efficiencies shown by jitneys over the long run if they were allowed to enter the travel market on a large scale.

Generic categorization of the common service innovations into dial-a-ride, taxi, car pool, and bus has been useful for initial identification and understanding of their operating characteristics. This classification has been inadequate, however, for defining and understanding their costs. This is because the organizational and institutional structures and management practices have greater impacts on costs than does the nature of the service. For example, from the standpoint of the service concept, a many-to-many dial-a-ride service (e.g., that in Rochester, New York) has more characteristics in common with a shared-ride taxi service (e.g., El Cajon, California) than it has with a dial-a-ride operation providing subscription feeder service to a line-haul commuter mode (e.g., Bay Ridges, Ontario). From the standpoint of costs, however, a publicly organized and operated, van- or bus-based, many-to-many, dial-a-ride service has more in common with a dial-a-ride subscription feeder service than it has with a privately owned and operated shared-taxi service.

The organizational distinctions between dial-a-ride and taxi operations will be emphasized here in an attempt to classify them. Thus, in this paper, dial-a-ride refers principally to van- or bus-based services that are publicly organized, use union drivers, and operate in a heavily regulated environment. Taxi services, on the

other hand, refer to privately owned and operated services that typically use low-wage drivers and standard automobiles and operate in a relatively less stringent regulatory environment. Thus, taxi operations include group, shared-ride, and taxi-based dial-a-ride services (e.g., El Cajon; Levittown, New York; Davenport, Iowa; and St. Bernard Parish, Louisiana). Taxis can and do provide the same range of services as publicly operated dial-a-ride systems.

## Different Markets

It is useful to distinguish the different markets in which the various innovative services currently operate or could be potentially provided. The trip and cost characteristics of a service across markets may be very different. Thus, cost and productivity comparisons make sense largely in a particular market. For the purpose of this discussion, three markets have been identified in which the service innovations are concentrated: (a) the low-density market that has a diverse set of origins and destinations, (b) the line-haul feeder market, and (c) the home-to-work commuter market. Each has distinct travel requirements. The low-density market that has diverse trip patterns can be served by dial-a-ride (as in Rochester and Ann Arbor, Michigan), taxi (as in Davenport and El Cajon), and conventional bus operations. This market consists of late evening, weekend, midday, and other low- or medium-density travel demands—particularly those having diverse sets of origins and destinations. A market consisting of the elderly, the handicapped, and others not able to use automobiles also belongs to this category. Dial-a-ride (Ann Arbor and Bay Ridges), taxi (St. Bernard and Peterborough, Ontario), and conventional bus operations also serve the line-haul feeder market. The home-to-work commuter market is typified by regularly scheduled trips with a long line-haul portion. Neither dial-a-ride nor taxi operations are particularly suited to serving this type of trip. Car pools, van pools, and subscription buses (e.g., Reston, Virginia; Specialty Transit in St. Louis, and Golden Gate in California) are appropriate for this travel.

This classification of markets enables us to identify the ranges of costs and productivities for particular generic modes. The cost and productivity variations among services across different markets are probably due mostly to their different sets of operating parameters (e.g., average speeds and route deviations).

## COSTS OF DIFFERENT SERVICES

Costs of providing service by different paratransit operations common in the particular travel markets are summarized in Table 1. Conventional bus is included for two of the markets because, traditionally, it has provided service in these markets, and thus it serves as a benchmark. The costs per vehicle hour are empirically-based numbers. The potential for decreasing the costs of dial-a-ride exists, because in principle, these costs can be as low as the lower costs of taxi operations. The costs of public systems shown exclude vehicle purchase costs, while those of privately run systems include them. The costs per seat hour are derived numbers that account for the effect of the size of vehicle. Costs per seat-travel distance can also be derived if seat-travel distances per vehicle hour are known or can be estimated. There are significant variations in costs per vehicle hour (even within a particular travel market), but the variations in costs per seat hour and costs per seat-travel distance are smaller. In general, larger vehicles have larger costs per vehicle hour, but smaller costs per seat hour.

Table 1. Costs of different paratransit operations in various urban travel markets.

| Travel Market | Type of Paratransit Operation | Cost ($) Per Vehicle Hour[a] | Cost ($) Per Seat Hour[b] |
|---|---|---|---|
| Commuter (few-to-one)[c] | Car pool | 3.00 to 6.50 | 0.75 to 1.60 |
| | Van pool | 7.00 to 11.00 | 0.60 to 0.90 |
| | Subscription bus | 10.00 to 60.00 | 0.20 to 1.20 |
| Low density (many-to-many) | Conventional bus | 12.00 to 30.00 | 0.25 to 0.60 |
| | Dial-a-ride | 10.00 to 25.00 | 0.80 to 1.65 |
| | Taxi | 5.00 to 10.00 | 1.25 to 2.50 |
| Feeder (many-to-one) | Conventional bus | 12.00 to 25.00 | 0.25 to 0.50 |
| | Dial-a-ride | 10.00 to 25.00 | 0.80 to 1.65 |
| | Taxi | 5.00 to 10.00 | 1.25 to 2.50 |

[a] Observed (1, 2, 3).
[b] Derived by using estimates of seats per vehicle.
[c] Ranges are due to differences in trip length and (for subscription bus) organizational diversity.

Within each of the travel markets, the costs per hour of each type of service show a wide range. There are several reasons for this. The variations for car and van pools in the commuter market are simply due to the different trip distances assumed (e.g., the range of $3.00 to $6.50 for car pools). Costs of these operations are primarily vehicle-travel-distance related if no hourly paid operator is used. Thus, the costs per hour of longer trips that allow faster speeds are higher. The variations in subscription bus operations are due partly to variations in trip distances and partly to the different organizational and ownership arrangements. The lower value ($10.00) is for short trip distances and services such as that exemplified by Specialty Transit that is operated much like a car pool—with the members sharing the driving burden and vehicles being owned and maintained privately—resulting in very low costs. The higher value ($60.00) at the other extreme is for long trips and services such as the Reston Express where the vehicles are leased from the local transit agency whose lease rates include the heavy burden of highly paid union drivers and the pro rata burdens of high administrative and overhead costs typical of many large transit companies.

In other travel markets, the variations for a particular type of operation within a market are primarily attributable to differences in local wage rates, labor rules, and dispatching policies. These factors account for the variations in dial-a-ride service costs of $10 to $25/vehicle•h. For example, the dial-a-ride operation in Santa Clara County, California, costs $20/vehicle•h with a driver wage rate of $6.85/h while the Benton Harbor operation with a driver wage rate of only $3.40/h costs $13/vehicle•h. Operations that use midibuses instead of vans are more expensive, partly due to high maintenance costs. The range of $5 to $10/vehicle•h for taxi-based operations also reflects different wage rates and labor practices.

Costs of privately owned, taxi-based operations (e.g., El Cajon and Levittown) are significantly lower than those of publicly operated, van-based dial-a-ride operations (e.g., Ann Arbor and Santa Clara County). Typically, the maintenance, labor, administrative and overhead, and dispatching costs are lower for experienced, privately owned and operated taxi firms than for recently established, publicly owned dial-a-ride operations. A synthesis of the costs given above shows that four critical factors determine the cost per vehicle-hour or per seat-hour of a particular service. These are summarized in the following discussion.

## Labor Use

This is probably the single most critical determinant of costs because labor typically accounts for almost 80 per-

cent of transit costs—driver's wages and benefits represent approximately 50 percent and other workers' wages and benefits represent approximately 30 percent of the costs of transit services. The low-cost operations described above, in most cases, have relatively low operator costs. Some have been able to hire operators at low wages (through employment of nonunion drivers or those belonging to unions with weak negotiating positions), some use part-time drivers (students and housewives), some use drivers with flexible split-shift rules, and some use idle drivers in off-peak hours. Low operator costs may be possible through direct labor agreements or through innovative organization of the service where vehicles and operators are leased from other firms that are able and willing to arrange for leases at incremental costs. Charter bus and transit companies, commuter van-pool operators or organizers, and taxi and limousine companies are possible sources of such arrangements so long as the innovative service being considered operates during the off-peak period for the leasing firm. For example, innovative commuter services could lease vehicles or operators at low cost from charter companies that generally operate outside commuter hours. Similarly, owl and weekend services and off-peak, many-to-many services in low-density areas might lease low-cost vehicles and drivers from limousine, transit, or taxi companies.

## Ownership and Organization

The way in which vehicles and operators are acquired can be critical for costs of innovative services. Most existing services operate their own vehicles and employ their own drivers. The above discussion suggests, however, that leasing of vehicles might be cost-effective if the lease is feasible at incremental, rather than average, costs or if the lessor can provide drivers with lower wage scales. The evidence also suggests that the costs of publicly organized and operated dial-a-ride services have been significantly higher than those of privately owned, highly competitive, profit-motivated services (e.g., taxi and shared-taxi operations). This is most likely because the successful owners and operators of the latter have usually evolved many cost-saving techniques and procedures and make lower profits. The efficient faction of the taxicab industry has long experience with such services and managerial skills for efficiently dealing with dispatching, employee utilization, and vehicle maintenance. Their overheads have been brought down over the years. Their operating costs are low because of skillful management of maintenance, lower driver wages (taxicab owners have usually been able to attract nonunion drivers or those belonging to relatively weak unions, and the competitive labor market structure has minimized labor wage spirals), flexible work rules, and use of part-time workers.

Publicly operated, van- or bus-based dial-a-ride services have had high costs per vehicle hour. Lack of experience has resulted in high overheads, high maintenance, and high dispatching costs. Reliance on transit union operators (in most cases required by the institutional organization) has meant heavy labor costs. Unfortunately, even the vehicle itself has often proved costly to own and maintain.

Labor pressures have traditionally been less severe in the taxi industry. Although they may increase in the future, particularly if the industry enters the markets of concern on a large scale, the pressures will probably be lower due to the open-market labor situation and fewer regulatory constraints. On the other hand, labor pressures in public systems will increase—particularly in the current and foreseeable environment of assistance, subsidies, and budgets. With large fixed budgets and formula-based allocation of outside subsidies, there appears to be little opportunity or incentive for management to bargain hard at negotiating time. However, some agencies have been able to do this—either by dissuading drivers from unionizing or by keeping the wage spiral at a low level. This has been achieved with an argument stressing mutual benefits to both parties. Transit unions appear to be tending toward greater flexibility. For example, there may be an agreement to accept significantly lower salaries for paratransit operations in Cleveland, and a similar agreement is evolving in Rochester.

Public operations can learn a great deal from the more able segments of the taxi industry regarding efficiency in maintenance, dispatching, administration, vehicle purchase, labor utilization, labor negotiations, and incentive structures. At the very least, the publicly operated services can probably learn about dispatching and overall management.

However, although efficient segments of the taxi industry might provide lessons to publicly owned systems, some caution is necessary. Not all taxi operators are efficient. Many are on the edge of bankruptcy. Labor exploitation and hard working conditions are said to exist. The potential for efficiency might be greater, however, with a competitive environment and a profit motivation.

## Regulatory Environment

The relatively favorable cost structure enjoyed by the taxi industry is due partly to astute management and partly to the institutional environment. Although the taxi industry operates under regulatory restrictions on entry, exit, service changes, and competitive activities, these restrictions are much less severe than the institutional environment of the transit industry. The transit industry has not been able to respond to changing markets and labor situations as quickly as the taxi industry. Less regulation is reflected in lower costs for taxi service in areas such as Washington, D.C. For example, taxis can reduce or increase services (within limits)—areas of coverage, times of operation, and routes can be adjusted. This flexibility allows better labor utilization and increases output (seat travel per vehicle-hour). To some extent, low taxi costs reflect practices that might be illegal or semilegal (e.g., low insurance coverage and service refusal). However, flexibility in tailoring service coverage, duration, and routing can help lower costs of all operations. A successful campaign for less regulation can improve the cost picture for both private and public services by encouraging more competition and allowing greater operating flexibility.

## Vehicle Characteristics

Size and type of vehicle have a direct impact on costs. Larger vehicles (with more seats) generally have lower costs per seat-hour. However, automobiles, small vans, and large conventional buses are likely to be more cost-effective than midisized buses. Midibuses have been observed to have greater maintenance costs per seat when compared with large buses or vans and cars, probably because there is little experience in maintaining them. Acquisition costs per seat for these vehicles have also been relatively high, probably because very few vehicles of this type are being manufactured. In spite of their cost advantage per seat-hour, large vehicles make sense only in situations where high vehicle use or productivity can be achieved. In most markets (except the peak-period commuter travel market), the productivities achieved are likely to be so low that vehicles larger than

vans are seldom appropriate. Even for the commuter market, only very long trips and high patronage justify large vehicles.

The comfort and convenience features of a vehicle (e.g., air conditioning, lifts for the parambulatory, seat cushions, and communication systems) also affect the cost. On the other hand, these features increase the quality of service. Thus, a potential reduction in cost per vehicle-hour must be judged in the light of possible decrease in patronage and hence a possible increase in cost per trip. (A similar situation is encountered in considering reducing dispatching costs by eliminating the callback to the prospective user about the pickup time and possible variance.)

The above discussion suggests several strategies for reducing the costs of the different service innovations. The common elements are (a) reducing labor costs by using part-time or low-wage operators or operators who are being paid for the time but are temporarily idle; (b) introducing taxi-industry management know-how to publicly operated, transit-based service; and (c) using the taxi industry as providers of service. However, these are not easy tasks. Special incentives will be needed to entice taxi operators into becoming providers of paratransit operations. Moreover, one might want to guard against the possibility of provider side contracts that reduce competition and efficiency. Cartel developments (e.g., Orange County, California) are also not desirable. The userside-subsidy concept might be one efficient way of providing the required incentive to taxi operators without sacrificing efficiency and competition.

## VEHICLE PRODUCTIVITY AND PATRONAGE

Vehicle productivity is crucial in determining the viability and efficiency of the service. Productivity provides a proxy measure of vehicle occupancy for calculating the success measure (cost per trip). There are several alternative measures that can be used (e.g., passenger trips per vehicle-hour or seat-hour, passenger trip distances per vehicle-hour or seat-hour, or passenger trip distances per vehicle unit distance). Each measure defines the level of success in attracting patronage. The first measure is most commonly used for the innovative services since the costs of other services have traditionally been defined in this way. However, the measure of trips per seat-hour might be more appropriate because it accounts for vehicle size. And the use of passenger trip length might be even more appropriate because this is a much better indicator of user benefits than is number of trips per se. This measure has not been commonly used because the measurement of passenger trip length per passenger has been difficult and because fares are usually determined on a trip basis rather than on a trip-length basis (which would more closely reflect costs). The last measure, which defines productivity on a vehicle or seat distance basis, probably provides a much better perspective on the actual operating load factors and hence is potentially more useful in making decisions about vehicle size.

The productivities of existing operations are summarized in Table 2. The values given for dial-a-ride, conventional bus, and single-ride-taxi (regular) operations are typical numbers observed. The shared-taxi productivities are estimates since little empirical evidence exists. Variations across different travel markets are significantly greater than are variations among services within a particular market. Typically, the productivities of commuter-pool services are the highest. These modes are characterized by high overall speeds due to small route deviations and dwell periods and the highly predictable nature of demand with fixed origins and destinations. On the other hand, the productivities of operations within the low-density market are very low. This is principally due to their low demand density, relatively large route deviations, low effective speeds, and diversity of origins and destinations. The lowest values for each operation in this market are for late night and weekend services, but productivity of conventional buses in this market could possibly be even lower than that of dial-a-ride services. Variations across operations within a particular market represent a wide range in quality of service (access characteristics, waiting times, and travel times). For example, the shared-taxi productivities are 50 to 100 percent greater than the regular taxi productivities. However, the level of service provided by the former is lower. The variations also represent operations in different locations.

The productivity of a particular operation is influenced by various factors: (a) type and quality of service, (b) level of vehicle utilization, and (c) level of patronage.

Productivities can be improved by increasing the overall vehicle travel distance per vehicle-hour. However, a particular operation is exemplified by the type and level of service it provides. Thus, although increased overall speeds and productivities can best be achieved through curtailment of service, this causes the quality of service to deteriorate. For instance, dwell time can often be a significant proportion of total time; several dial-a-ride operations have reported dwell times of 2 min/pickup. For an operation with an average productivity of 6.0 passengers/h, about 10 min/h of operation might be saved if dwell time were eliminated. The speeds and productivities can be increased greatly by reducing the dwell time. However, such reductions result in lower service levels. For example, dwell time can be reduced by eliminating the doorstep escort service provided by many dial-a-ride operations, but use by the elderly and handicapped will then decrease. Similarly, a changeover from door-to-door to block-to-block service reduces route deviation significantly and increases productivity (as exemplified by operations in Ann Arbor and Merced, California). But, the service level will decline. Many dial-a-ride operations have reported that long times are required to find addresses after the request for service is received. This time can be shortened if the level of demand responsiveness can be sacrificed. Requiring requests well in advance (1 or 2 h or even 1 d in advance) would enable prior search and reduce pickup time. In

**Table 2. Vehicle productivities of different paratransit operations in various urban travel markets.**

| | | Productivity | |
|---|---|---|---|
| Travel Market | Type of Paratransit Operation | Passengers per Vehicle Hour[a] | Passenger Trip Distances per Vehicle Hour[b] (km) |
| Commuter | Car pool | – | 48.0 to 240.0 |
| | Van pool | – | 144.0 to 576.0 |
| | Subscription bus | – | 560.0 to 1680.0 |
| Low density | Conventional bus | 2.0 to 20.0 | 6.4 to 64.0 |
| | Dial-a-ride | 3.0 to 10.0 | 9.6 to 32.0 |
| | Taxi | | |
| | Regular | 2.0 to 3.0 | 6.4 to 9.6 |
| | Shared | 2.5 to 6.0[c] | 8.0 to 12.8 |
| Feeder | Conventional bus | 20.0 to 30.0 | 48.0 to 72.0 |
| | Dial-a-ride | 8.0 to 20.0 | 19.2 to 48.0 |
| | Taxi | | |
| | Regular | 2.0 to 3.0 | 4.8 to 7.2 |
| | Shared | 2.5 to 8.0[c] | 5.6 to 12.0 |

Note: 1 km = 0.6 mile.
[a] Observed (1, 2, 4).
[b] Derived using hypothetical (but plausible) estimates of passenger trip distance per passenger.
[c] Observed values fall between these hypothetical (but plausible) extremes.

summary, reductions in dwell time and deviation, although very effective in increasing productivity, essentially change the level of service. However, many dial-a-ride operations have productivities so low that they might have no choice but to reduce service levels if there is a desire to raise the productivities.

Level of vehicle utilization (vehicle travel distance per hour) is another factor affecting output. Thus, productivity can be increased through improvements in effective speed. Two possible methods for this are to provide priority treatment for the vehicles in traffic and at intersections and to improve vehicle performance. Although, for most operations, the potential improvements do not appear very significant, vehicle-performance improvements can lead to higher overall speeds in cases where large vehicles are being used. Small vehicles—particularly standard automobiles—show much better acceleration, deceleration, and braking characteristics than do large vehicles—particularly minibuses. In services that require frequent stops for pickups or due to traffic conditions, small vehicles can achieve significantly higher average speeds. This has been observed in Orange County. The other method for achieving better overall utilization of the fleet is through improved control strategies—dispatching procedures, deadhead policies, and strategic prepositioning of empty vehicles. For large systems, computerization may help evolve efficient operating policies. These actions might offer some potential for improved productivities without significantly affecting the quality of service.

The third important factor is the patronage the service is able to attract, since significant economies of scale exist in these operations. In general, productivities increase with demand density. There are limits to the extent to which this can be done, beyond which the productivity cannot be increased without a significant decrease in service, but it is believed that none of the operations has reached these limits. Thus, higher demands will bring increased productivities in most of the service innovations. Higher patronage would require effective and aggressive marketing. More information is needed about the aspects of service valued most by the various types of potential travelers. This would help in efforts to tailor the services accordingly and devise effective campaigns to attract riders. Much more information about the elasticities of the various markets with respect to different aspects of service should be developed and analyzed.

In summary, then, adjusting the service level downward provides the greatest opportunity for improvement in productivity. This, however, requires the careful tailoring of services and reevaluation of the market to be served and the level of service to be provided. To an extent, some privately operated taxi operations (e.g., Davenport; Hicksville, Long Island; and Levittown) have been able to do this. Perhaps their instinct to survive in a competitive market and make profits has led them to implement many of the improvement measures described above. But again these appear to be exceptional cases. Many other taxi operators are struggling to stay in business and could themselves benefit from more efficient dispatching and control strategies.

## COSTS PER PASSENGER TRIP

In the preceding sections, total costs of providing service (dollars per vehicle-hour) and productivities (passenger trips per vehicle-hour) have been discussed. Total costs represent the value of resources consumed in providing a particular operation. Total costs and productivities together determine costs per passenger trip. Thus, costs per trip can be decreased either by decreasing total costs or by increasing productivities. The prices that the users face—fares—have had little relation to the cost of providing their trips, except in privately run systems operating for profit. In publicly operated systems, typically, the user costs or fares charged to ride the system have been only small fractions of the costs of providing the trips. Thus, these systems have required heavy subsidies.

Table 3 summarizes the existing evidence on costs per passenger trip and per passenger trip length for the various types of operations. Low-cost operations signify relatively more attractive cost performances and productivities. Again, comparisons across travel markets have significance only for illustrative purposes. These represent significantly different trip characteristics. The commuter-pool trip costs are lower because of low total costs and high productivities. Within other markets, the dial-a-ride operations have costs per trip that are somewhat higher than private taxi-based operations, reflecting, principally, the better cost performance of the latter. In spite of lower productivities, taxi trip costs are low. The differences among services within a particular market are due to various causes, such as different service levels, total cost performances, and productivity achievements. The upper range of trip costs for public operations serving the low-density market are particularly revealing. These extreme values represent weekend or late night services for which drivers are paid high overtime wages and the patronage and productivities are extremely low. The large values shown at the high end for taxi operations are hypothetical. The taxi industry, which is basically unsubsidized, generally chooses to not serve these market conditions. More important are the low values. These low costs are probably achievable.

It is important to remember that the ranges shown within a particular market represent the wide range in quality of service provided by existing operations in a diverse set of locations. Thus, a comparison of the lowest values does not necessarily suggest the cheapest operation. For example, the $0.60 cost for conventional bus is for service in a medium or higher density area, while the $0.80 cost for dial-a-ride is probably from a low-density area. In aggregate, it appears that in the low-density markets where existing dial-a-ride operations are concentrated, the operating environment is such that the costs per trip of public dial-a-ride operations providing a particular level of service are likely to be lower than those of a conventional bus service providing the same level of service. In this environment, a privately operated shared-ride taxi will possibly be even less expensive than the publicly operated dial-a-ride service.

### Fares (User Costs) and Subsidies

The economic and financial stability of paratransit operations depends on both the costs per trip of providing the service and the fares that are charged. If the fares are lower than the costs (as with most dial-a-ride and conventional bus operations), public subsidies become necessary. Table 4 presents the costs incurred in providing the various services, the fares actually charged (paid by the users), and the differences (which amount to the net subsidy per passenger). Car pools, van pools, and subscription bus operations generally raise sufficient revenue from users to pay their costs. There are examples, however, of indirect subsidies: Some subscription bus operations receive small subsidies (e.g., Golden Gate) and some of the costs of organizing company van pools are absorbed by employers and not reflected in the costs considered in Table 1. On the whole, however, where

such subsidies exist, they are very small. Moreover, the market is probably such that even if these extra costs were passed on to the users in terms of small increases in fares (subscription rates), the operations would remain quite healthy.

Privately operated taxi services apparently receive no direct subsidies. The fares pay the costs of providing the service. That these services charge relatively high fares and still continue to operate suggests that their level of service is highly valued by the market in which they operate. This may actually suggest that the current fares on dial-a-ride and bus systems are too low. Of course, the taxi industry is not healthy across the board; many operators are in precarious financial situations. Thus, over the long run, public subsidies might be required to entice them into other markets on a large scale.

The financial conditions of dial-a-ride and transit operations are not very attractive. They have required significant levels of public subsidies. Although the values in Table 4 suggest this, the actual conditions are probably even worse. For example, Ewing and Wilson (3) indicate that dial-a-ride operations are able to raise only 10 to 40 percent of their costs from the fare-box. This has created tremendous pressures on local budgets. At present fare levels, these operations may not be able to survive for long unless there are significant cost reductions.

Table 3. Costs per passenger trip.

| Travel Market | Type of Paratransit Operation | Cost ($) Per Passenger Trip[a] | Per Passenger Trip Kilometer[a] |
|---|---|---|---|
| Commuter[b] | Car pool | – | 0.06 to 0.03 |
| | Van pool | – | 0.05 to 0.02 |
| | Subscription bus | – | 0.02 to 0.04 |
| Low density[c] | Conventional bus | 0.60 to 15.00 | 0.20 to 4.70 |
| | Dial-a-ride | 1.00 to 8.00 | 0.30 to 2.50 |
| | Taxi | | |
| | Regular | 1.70 to 5.00 | 0.55 to 1.50 |
| | Shared | 0.80 to 4.00 | 0.35 to 1.25 |
| Feeder | Conventional bus | 0.40 to 1.25 | 0.20 to 0.50 |
| | Dial-a-ride | 0.50 to 3.00 | 0.20 to 1.25 |
| | Taxi | | |
| | Regular | 1.70 to 5.00 | 0.65 to 1.95 |
| | Shared | 0.60 to 4.00 | 0.40 to 1.70 |

Note: 1 km = 0.6 mile.

[a] Derived from Tables 1 and 2.

[b] Variations within each type of operation reflect different trip lengths (differences in average speeds) for the three services. Organizational structure also contributes to the variations shown in costs of subscription bus operation.

[c] Within a type of operation, the high costs are for systems with expensive total costs providing owl and weekend service with very low productivities. The low costs are for relatively inexpensive operations providing service with higher productivities.

Table 4. Trip costs and fares.

| Travel Market | Type of Paratransit Operation | Cost per Passenger[a] ($) | Fare per Passenger[b] ($) | Subsidy per Passenger[b] (net public cost) ($) |
|---|---|---|---|---|
| Commuter | Car pool | – | – | 0 |
| | Van pool | – | – | 0 |
| | Subscription bus | – | – | 0 |
| Low density | Conventional bus | 0.60 to 15.00 | 0.25 to 0.50 | 0.50 to 14.00 |
| | Dial-a-ride[c] | 1.00 to 8.00 | 0.25 to 0.60 | 0.50 to 7.00 |
| | Taxi[b] | | | |
| | Regular | 1.00 to 2.00 | 1.00 to 2.00 | 0 |
| | Shared | 0.80 to 2.00 | 0.80 to 2.00 | 0 |
| Feeder | Conventional bus | 0.40 to 1.25 | – | – |
| | Dial-a-ride | 0.50 to 3.00 | – | – |
| | Taxi[b] | | | |
| | Regular | 1.00 to 2.00 | 1.00 to 2.00 | 0 |
| | Shared | 0.60 to 1.50 | 0.60 to 1.50 | 0 |

[a] Derived.

[b] Observed.

[c] Typically, dial-a-ride trip costs in this market are $1.25 to $2.00 while fares are between $0.25 and $0.50. Thus, subsidy per passenger has been more than $1.00.

## Fares, Demand, Quality of Service, and Trip Costs

Before concluding the discussion of trip costs, it might be useful to explore the trade-off among fares, demand, quality of service, and trip costs. Unfortunately, little hard evidence exists that would provide definitive guidance regarding these factors and the interactions among them. However, some tentative observations can be made. The preceding discussion has suggested that productivities and costs per trip can be improved significantly if sacrifices in quality of service are acceptable. This observation needs to be qualified. There is a two-way relation between productivity and quality of service. Cutting back some aspects of service (e.g., escort service or door-to-door operations) could bring about a proportionately greater reduction in patronage and thus increase trip costs. This can happen in a service catering to the elderly and handicapped, for example. The critical point here is the value that potential travelers put on the aspect of service involved. If the demand is very inelastic with respect to the aspect of service, cutbacks will not decrease patronage greatly. Unfortunately, we know little about such measures of elasticity or where they might become critical. It is believed, however, that most services are operating under conditions where some cutbacks would be cost-effective.

Fare charged has much the same implications. Currently, the demand served by these operations appears to be fare inelastic, except perhaps for certain special groups such as the elderly. This observation is reinforced by the success of taxi operations in attracting significant ridership at much higher fares. If this is indeed true, then some increase in fares would not reduce patronage greatly. Thus, the decline in productivity and the resulting increase in costs per trip would be minor. But in most cases, the economic situation would improve because the additional fare would bring in greater net revenues, which would decrease the net public costs (subsidies). This scenario must remain tentative until greater evidence about fare elasticities is available. If the fare elasticity for a particular service is high, a fare increase would bring about a significant decrease in productivity, which would result in a large increase in costs per trip—possibly more than the increased revenues, thus increasing the requirements for public subsidy.

## Potential for Decreasing Costs per Trip

This paper has emphasized two approaches to lowering the costs per trip of innovative services: (a) increase productivity and (b) decrease costs. Over the long run, the reduction of total costs probably holds greater promise for improvements in costs per trip.

Commuter pool services have little opportunity to increase productivities, which are already high. Poolers already enjoy special privileges, such as close-in parking. The occupancies and productivities might be improved somewhat if measures were adopted that produced a wider difference in the prices faced by pool members and those faced by single-occupant automobile drivers. One possible, but politically difficult, proposal is to require automobile drivers to pay large additional fees for parking. So far as costs are concerned, little opportunity exists except for making incentives, such as excise-free fuels or tax breaks, available to poolers. Subscription bus operations could reduce costs, in some cases, by changing leasing practices and by using members as drivers.

The potential for reductions in costs per trip is probably greater in markets other than the commuter market. Strategies for productivity increases have been discussed above. The potential is, however, very limited if adjustments in service are prohibited by the local regulatory environment or other factors. Even if service curtailments are feasible, only a limited number of actions can be taken. Ubiquitous dial-a-ride services are probably undesirable. Dwell-time reduction and overall speed increases are somewhat promising, but beyond these, large cutbacks in dial-a-ride services might produce significant decreases in patronage and so lose the productivity gains. Dial-a-ride has greater potential for such improvements than do private taxi operations. Aside from service cutbacks, the streamlining of control strategies is perhaps the only means for productivity increases. In large operations, computerized routing, scheduling, locating empty vehicles, and deadheading strategies can bring about some productivity improvements.

The opportunity for reduction in total costs appears to be much greater for nonpool services. This potential is, however, heavily constrained by existing regulatory and labor arrangements. At least over the short run, there are good opportunities for reductions in labor costs (which account for a large portion of the total costs), as exemplified by taxi operations, provided that agreements with local labor unions can be reached. Arguments about mutual benefits might succeed, and negotiations might lead to compromises. For example, in return for additional employment, organized labor might agree to allow some participation by part-time or nonunion drivers or even be willing to renegotiate items such as split-shift penalty clauses. These actions are feasible, but would require education and hard bargaining over a period of time. A more immediate possibility is to organize multiple services, where possible, so that drivers and rolling stock are used more effectively. Diversification rather than dedication to a single service should be the aim of the operators. In fact, this is where some taxi operators have been able to do well. The competitive environment and necessity for profits have forced them to evolve multifaceted services. This possibility of providing additional service at a low incremental cost (primarily because drivers and vehicles are often idle) has attracted them to providing feeder and other innovative services.

Overhead and administrative practices are other areas where cost-reduction potential exists—particularly for dial-a-ride services. Typically, publicly owned, transit-based dial-a-ride operations have heavy administrative and overhead costs. Taxi management experience probably can provide useful lessons here. Dispatching, maintenance, labor utilization, and other practices used by efficient taxi operations could produce significant cost reductions in dial-a-ride operations. Again, the key to achieving efficiency is competition. Thus, formation of exclusive franchises should probably be discouraged.

## POLICY IMPLICATIONS AND ISSUES FOR DISCUSSION

The discussion above reveals several issues of policy relevance. There are implications for the directions in which research and development of innovative services might evolve. There are lessons for areas considering such services. In low-density areas with diverse travel desires, the costs of providing service are high. Moreover, the available evidence, although not definitive, suggests that less formally organized, privately owned, competitive and profit-motivated, weakly regulated services have lower costs per trip and are less expensive on a net revenue basis. Although there is probably some potential for cost reductions, particularly in publicly owned, dial-a-ride operations, trip costs are likely to remain high. For these markets, the question of the worth of service arises. Dial-a-ride operations are certainly less expensive than fixed-route buses, but do they provide benefits worth their costs? Could some markets be best left to be served by taxi operations with special direct provisions for the needy through userside subsidies? If there are no significant cost reductions and productivity increases in dial-a-ride services as currently operated, then their future growth will be slow.

The currently available cost and productivity information is not sufficient for the development of definitive guidelines for these operations because the evidence about the trade-offs among quality of service, cost per trip, fare levels, and patronage is limited. It has been difficult to assess the level of improvements in costs, productivities, patronage, and revenue associated with these services and to rationally tailor a service to the needs of a particular market.

Some possible items for consideration are summarized below.

1. What are the trade-offs among cost per trip, patronage, quality of service, and fare levels? What is the current experience? Are service cutbacks an effective means of increasing productivity? Are most publicly operated services underpriced?
2. What is the potential for reducing control and dispatching costs and what would be the impact on quality of service? Are significant improvements forthcoming?
3. What is the potential for cost reductions through significant changes in the organizational structure of these services? Is it feasible to bring taxi management experience into dial-a-ride operations? What is the potential value? What potential conflicts might arise? Would public interest be sacrificed?
4. Can the taxi industry be induced to participate in dial-a-ride operations on a large scale under the existing regulatory guidelines? The taxi industry is believed to be in marginal financial condition and might need some incentives to enter the new markets. Are such incentives feasible and economical? Can labor costs be kept down if the taxi industry enters these markets on a large scale? Can they sustain low overhead and dispatching costs? Will the public interest be in jeopardy? Will service refusal be a problem?
5. What priority treatment techniques might help increase productivity? By how much?
6. How can labor costs be reduced under the existing arrangements? For new services, would labor unions be willing to share the available work? Would they agree to some nonunion participation if a certain amount of new employment is guaranteed for them?
7. What are the sources for leasing vehicles at low incremental costs? Can commuter van-pool vehicles be used in off-peak dial-a-ride service? Are there other possibilities?
8. Should van-based dial-a-ride operations shift to automobile-based services? If their productivities cannot be increased, this may be more cost-effective.

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# Legal and Institutional Considerations in Paratransit Innovations

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**Transportation has a rigid background of laws, regulations, and business practices developed during the late 1800s that strongly influences the transportation options available today. This paper examines some of the assumptions on which these policies and practices are based. Several alternative approaches and ways in which they could be implemented are suggested. In addition, specific laws and practices that may need to be reevaluated are identified.**

To understand the current institutional issues facing paratransit, it is first necessary to develop an overall understanding of paratransit trends. Paratransit is by no means a novel concept in the present regulatory structure in the United States. The concept has developed over a period of at least 200 years. In the early 1800s, anyone with a horse and wagon or buggy could haul people for hire, and entry into the paratransit business was easy. There were no restrictions, and there were very few, if any, regulations. The investment required was minimum, and the transportation business itself was highly competitive. For example, the New York horsecar operation was characterized by many individual owner operators who were local people and knew their passengers' special needs. Without regulation, the only protection for the passengers was that imposed by the judiciary; i.e., common carriers were required by the courts (as they are now) to exercise the highest degree of care for the safety of their passengers and their passengers' property.

During the last half (and especially the last quarter) of the nineteenth century, there was a significant change in the nature of the public transportation business. The highly capitalized railroads represented a massive leap in technology over leg power, water power (canals), and horse or ox power. On the municipal level, the horsecar lines were replaced by cable traction in the 1870s and electric streetcars in the 1880s.

The development of the electric streetcar resulted in a significant change in the method of providing public transportation because of the significant economies of scale associated with their operation. They were frequently owned by the municipal power company. A city would grant the power company an exclusive franchise to operate streetcars to the exclusion of other streetcar lines and, in return, impose certain burdens, such as obligations for street paving, maintenance, and lighting. In addition, certain taxes would be imposed. The service provided by the street railway companies was also regulated in terms of setting uniform rates for fares, establishing routes to be traveled, and prohibiting the discontinuation of routes without the express permission of the city. As creations of the states, the cities had the power to exclude competition by withholding of franchises and imposing certain reasonable regulations on operations.

The courts did impose some limits on the ability of a municipality to set rates. One such limit was that due process of law required that the rates prescribed must ensure the company a fair return on the value it employs for the convenience of the public. In understanding present policy, this limitation is important because it serves as a limitation on the federal, state, and municipal power to set rates. Also, it imposes an affirmative obligation on the part of the governmental body to do all in its power to ensure a fair return on investment. On the other hand, because the amount of return is based on the capital used, the emphasis is on high capital investment and there is little incentive for the companies to reduce the amount of capital invested.

## RAILROAD-TROLLEY REGULATORY MODEL

As a result of the technological superiority of the railroads and trolley lines in the late 1800s and early 1900s, a public utility model was developed based on the following assumptions:

1. Transportation is a major component of people's lives, and the ability to control transportation availability and pricing is the power to determine which individuals, geographic areas, and businesses will prosper.
2. Government must regulate transportation to ensure that no individual, business, or region is unjustifiably discriminated against; fares are regulated to provide a reasonable and constitutionally permissive rate of return adequate for the continuation of the service, but low enough to prohibit monopolistic exploitation; schedules and service areas are such that all persons and businesses have access to an adequate level of transportation; and service in the unprofitable portions of the community is cross-subsidized through profits obtained from the exclusive franchise in profitable areas.
3. Because all costs will be essentially the same for any firm providing the required service and fares are regulated to prohibit excessive profit, any competition