COMPARISON OF PRIVATELY AND PUBLICLY OWNED DEMAND-RESPONSIVE SYSTEMS

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Urban transportation planners usually agree that urban systems can be put into 3 categories. One of these, multiple- or shared-ride, demand-responsive systems, has received comparatively little investigation and consideration as a workable form of urban public transportation. This paper deals with this form of urban transit. Six publicly owned shared-ride systems are compared with 2 privately owned systems. Similar variables are observed, and conclusions are drawn from the observations. The information indicates that the private systems are servicing a larger area with a smaller seating capacity. Both are attracting the same market segments, but the private systems are obtaining a higher average fare. This, coupled with the lower costs of the private operation, enables the private systems to operate at a profit while the majority of public systems operate at a deficit.

•URBAN transportation systems can be grouped into 3 categories based on levels of service. These 3 levels are

1. Traditional fixed-route, fixed-schedule transit service that typically uses large buses or rail systems;
2. Multiple-or shared-ride, demand-responsive systems that use intermediate-sized vehicles; and
3. Demand-responsive, single-ridership service that traditionally has been provided by private taxicab services.

These level-of-service categories have been developed to emphasize the degree to which the service responds to specific user needs. The traditional taxicab service, for example, provides a higher level of service than traditional transit does because the routes, schedules, and travel time are tailored more closely to the request of the user. Traditional transit requires that the user adjust his or her needs to the transit service available in order to use it. This much higher level of personalized service to the user, however, typically was offset by the higher fare structure.

Within the last 5 years, however, attention has been turned to the implementation of demand-responsive services that could attract those riders for whom traditional transit service levels were not acceptable and decrease the cost of traditional taxicab service levels through the use of ride sharing. In addition, shared-ride, demand-responsive systems have been viewed as more economical means of providing service to captive riders residing in low-density areas where large traditional transit vehicles are too expensive and fuel intensive and private taxi fares are prohibitive.

For many years local public bodies have prohibited the development of shared-ride, demand-responsive service by private companies because they believed that (a) traditional taxicabs should not be allowed to deny customers the highly personalized service

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that people normally expect from taxicabs and (b) shared-ride taxi service would attract too many riders from traditional transit companies in violation of the exclusive transit franchise that most transit companies hold. These views persisted after local communities began to purchase local transit properties. According to Davis et al. (1) and statistics from the International Taxicab Association, local transit authorities and contract management firms strongly contended that shared-ride taxicabs, jitneys, and even car pools were competition that only could hurt already deficit-ridden transit.

Consequently, shared-ride taxicab service typically has been limited to the few communities that did not have transit and started shared riding during World War II (or the 1973-1974 energy crisis) or that had special circumstances calling for shared riding during peak periods (to distribute commuters from rail stations to low-density residential areas, for example).

The continual decline in traditional transit ridership under public ownership stimulated the public sector to develop methods for (a) increasing service levels to attract new riders, (b) reducing the cost of service to captive riders in low-density areas, and (c) providing more economical feeder service to traditional line-haul transit routes. Hence the public sector began to develop publicly owned and operated shared-ride, demand-responsive service identified by names such as dial-a-bus or dial-a-ride to emphasize the demand responsiveness of the service. Because these services were offered by public agencies using full-time drivers and usually vans or minibuses, opposition from local regulatory bodies and publicly owned transit systems was minimized. Opposition has come, however, from the private taxicab companies that feel that this service is an unfair encroachment on their operating franchise. Many of the private taxicab companies argue that (a) they already are providing the service required, which makes additional service unnecessary, or (b) private companies can provide the desired level of shared-ride service at a lower cost than publicly operated service, which means that public agencies should contract with private companies for the service.

In many cases, public officials, planners, and social agencies have not known which approach to use to provide shared-ride, demand-responsive service. This paper uses the data developed in 2 major studies of demand-responsive, shared-ride transportation service to compare the results of these operations and predict the benefits of each approach. The first study examined 6 publicly owned and operated shared-ride services in the United States and Canada (4, 5). The second study examined 2 privately owned, shared-ride taxicab systems (3). The 6 publicly owned demand-responsive systems are in Ann Arbor, Michigan; Batavia, New York; Columbus, Ohio; Haddonfield, New Jersey; Bay Ridges, Ontario; and Regina, Saskatchewan. The 2 privately owned systems are Royal Cab Company of Davenport, Iowa, and Orange and White Cab Company of Hicksville, New York.

DESCRIPTION OF 2 PRIVATE DEMAND-RESPONSIVE SYSTEMS

The current demand-responsive, shared-ride taxicab system in Davenport, Iowa, was established in 1967. Before 1967, several small companies operated independently. The company currently operates approximately 20 taxicabs and generally employs more than 40 drivers. Drivers are encouraged to lease their vehicles on a weekly basis. The lease arrangement is designed to allow the lessee to retain the same vehicle over an extended period of time and to hire other individuals to operate the vehicle during second and third shifts on a commission basis. This was to foster pride in the equipment and enable the lessee to increase his or her weekly income. More specifically, the lease arrangement calls for a leasing fee of $240/week. The Royal Cab Company provides for insurance, vehicle maintenance and cleaning, licensing, dispatching, and technical assistance. The drivers must pay for the gas.

Management's emphasis on increased driver care was necessary before the company could justify the purchase of newer, air-conditioned cabs. The possibility of second-shift operation allows the lessee to increase his or her weekly income and also shifts employment coordination from the firm to the individual lessee, which thus eliminates

the need for road supervisors. Finally, it was hoped that the drivers would become more customer-oriented as they gained a larger stake in the profitability of their operation.

The company's rate structure is based on a zone system consisting of a central zone that encompasses the downtown business area and from which additional zones radiate. Consequently, fares are computed on the basis of distance from the central business district, and, because of this geographical orientation, the fare for a short crosstown trip can be substantially higher than that for a much longer trip that has its origin or destination in the downtown business area.

With regard to types of service provided, the demand-responsive transportation system in Davenport, Iowa, employs the concept of shared riding in which a customer may have to share the vehicle with passengers with whom he or she has no affinity and who may have different origins and destinations. No specified maximum or minimum intervals of time for waiting or riding are guaranteed although the company strives to provide as high a level of service in this respect as is consistent with the prevailing conditions of the taxicab system and the street network to foster good customer relations. It should be noted, however, that users may request direct origin-to-destination service (no intermediate pickups or deliveries) for a somewhat higher fare. In addition, cruising is not permitted by ordinance and in practice is restricted by the present lease arrangement that requires the driver to pay for his or her own gasoline. Flagging down a vehicle is not common, although drivers are permitted to serve such requests for rides.

The privately owned demand-responsive transportation system in Hicksville, New York, has been in operation since 1961. The company's fleet currently consists of approximately 30 passenger cars driven by 100 full- and part-time drivers. The lease agreement calls for a charge of 20 cents/mile (12.5 cents/km) driven, with a 50-mile (80-km) minimum, plus 50 cents/h for dispatching. The only other vehicle operating expense incurred by the drivers is for gasoline; the Orange and White Cab Company assumes all other vehicle operating expenses. These include maintenance, cleaning, insurance, licensing, and ordinary repairs. In order to maintain driver discipline, company policy stipulates that any damage to a vehicle that is the direct result of driver negligence must be repaired at the driver's expense. If the driver does not comply, he or she will not be allowed to renew the daily lease. The fare structure of the system is based on a combination zone-distance plan consisting of 6 overlapping arrangements of zones, each of which has a taxicab stand serving as a focal point. The company uses the shared-ride concept to increase vehicle use although, as in Davenport, Iowa, the customer can obtain nonstop or direct origin-to-destination service for a higher fare. The Orange and White Cab Company operation in Hicksville, New York, is heavily rail oriented; approximately 39 percent of all trips are to or from 1 of the rail terminals. Shared riding is especially heavy during this one-to-many and many-to-one operation.

As previously mentioned, these 2 shared-ride taxicab companies differ in the marketing strategies that they employ. The management of the Orange and White Cab Company feels that the demand for taxicab service is highly elastic. In experiments with lower fares, the management of the Orange and White Cab Company indicated that ridership increased but profitability decreased. Accordingly, their fare strategy has been to charge higher fares and carefully control the number of vehicles to increase profitability.

The Orange and White Cab Company has found that their ridership figures go up and down with corresponding fluctuations in the Long Island Railroad. Whenever rail fares increase and ridership declines, the Orange and White Cab Company experiences a similar drop in ridership. Also, as the railroad's ridership decreases, the level of competition increases between the Orange and White Cab Company and Hicksville's bus service for the decreased number of rail commuters. Bus fare increases shift more riders to taxicabs and vice versa.

The current operating strategy of the Royal Cab Company of Davenport, Iowa, is only the first step in the company's long-term plan for providing public transportation in Davenport. Simply stated, the long-run goal of the Royal Cab Company is to provide

3 distinct but coordinated levels of passenger transportation service: premium, shared-ride, and dial-a-ride service. In working toward this goal, the Royal Cab Company is following a step-by-step approach. Current marketing strategy consists of building user loyalty through low fares and high use of vehicles.

RIDERSHIP COMPARISON OF PUBLIC AND PRIVATE SYSTEMS

Table 1 gives a comparison of the population and density of each of the eight communities and the levels of service and ridership for each shared-ride, demand-responsive system.

According to these data, the Davenport, Iowa, cab company is operating over a larger area [19.7 miles^2 versus 5.4 miles^2 (51.22 km^2 versus 14.04 km^2)] with a slightly lower density [5,000 persons/mile^2 versus 6,222 persons/mile^2 (1900 persons/km^2 versus 2364 persons/km^2)] than the average publicly owned systems. Hicksville, New York, on the other hand, is in the same range of population and density as Regina, Saskatchewan, and Haddonfield, New Jersey, are. With the exception of Haddonfield, New Jersey, the publicly owned services ceased operations during the early morning and off-peak hours; both private systems, however, offered 24-h service.

Table 2 gives a comparison of operations in each of the communities. The dial-a-bus system typically uses vans or minibuses with capacities of 10 to 23 passengers. Most of the dial-a-ride systems operate over a very small area [2 to 4 miles^2 (5.2 to 10.4 km^2)] or bus-based feeder service only (Regina). Haddonfield, New Jersey, appears to be the only system that provides citywide, many-to-many service for an area greater than 4.3 miles^2 (11.2 km^2) that is similar to the service of taxicab systems.

Table 3 gives a comparison of wage rates and productivity. This comparison includes only the driver cost and the productivity required to cover the wages of the driver. Table 3 makes several points. Publicly owned dial-a-ride systems pay substantially higher wages than privately owned systems do although all systems pay substantially more than minimum wage. It should be emphasized that the wages for taxicab drivers did not include any tips. If tips are added, then wages for taxicab drivers may approach the Batavia and Bay Ridges wage levels. Comparisons of salary levels raise a number of interesting questions about the types of employees used by the respective systems. The dial-a-bus systems generally are operated by full-time professionals who operate a continuous shift under specific work schedules and rules similar to the traditional transit systems. The taxicab systems, on the other hand, are operated by individuals who value the independence of their jobs. Many drivers work part-time in conjunction with other jobs. Consequently, the supply of service can be readily varied to respond to actual demand levels.

Work rule flexibility is important for 2 reasons. First, successful private taxicab drivers may not make good public dial-a-bus drivers because of differences in expectations and work rules. Second, publicly owned systems with a highly structured work force may be substantially less flexible in meeting fluctuating demands at a reasonable cost. This difference in labor cost and flexibility raises an interesting question: Are the publicly owned dial-a-bus systems setting arbitrarily high wage levels for a widely available skill? Another point made by the data in Table 3 is that fare levels are substantially higher in the privately operated system. Consequently, fewer passengers are needed to cover the cost of labor. In each of the dial-a-bus systems total revenue was unable to cover the cost of the driver, much less make any contribution to overhead or other variable costs. The private systems, on the other hand, amply cover driver cost.

Table 4 gives the cost and revenue of trips in each of the comparative systems. These data indicate that the cost of each ride varies from $3.50 per ride in Haddonfield, New Jersey, to $0.58 per ride in Davenport, Iowa. These rides are not directly comparable, however, because the service area varies substantially between the systems. The Davenport, Iowa, system serves an area of 19 miles^2 (49.4 km^2); two-thirds of the

Table 1. Population, density, ridership, and other characteristics of 8 cities with second-level transit service (2, 4).

Type of Service	Population	Area ($mile^2$)	Density (persons/$mile^2$)	Hours of Operation	Average Weekday Ridership	Average Ride Time
Privately owned						
Davenport, Iowa	100,000	19.7	5,000	24 h	1,269	14
Hicksville, New York	48,075	6.8	7,100	24 h	924	18
Publicly owned						
Ann Arbor, Michigan	10,000	2.3	4,348	6:30 a.m. to 6:00 p.m.	190	13
Bay Ridges, Ontario	14,000	4.0	3,500	5:00 a.m. to 1:00 a.m.	600	11
Batavia, New York	18,000	4.3	4,186	6:00 a.m. to 6:00 p.m.	400	7
Columbus, Ohio	37,000	2.5	14,800	6:30 a.m. to 8:30 a.m. and 5:30 p.m. to 11:00 p.m.	396	19
Haddonfield, New Jersey	40,100	10.9	3,679	24 h	1,331	13
Regina, Saskatchewan	58,000	8.5	6,823	6:45 a.m. to 11:30 p.m.	3,400	18

Note: 1 $mile^2$ = 2.6 km^2, 1 person/$mile^2$ = 0.38 person/km^2.

Table 2. Characteristics of various transportation systems (2, 4).

City	Number of Vehicles	Capacity of Vehicles	Total Capacity	Staff	Type of Service	Nature of Service	Remarks
Davenport, Iowa	20 peak, 17 off peak	5	100	1 dispatcher, 1 telephonist	Taxi based, shared ride	Many to many	Dispatcher assigns passengers and at times exact routes; reduced fares for groups; package delivery
Hicksville, New York	26 peak, 23 off peak	5	130 peak, 115 off peak	1 dispatcher, 1 to 2 telephonists	Taxi based, shared ride, citywide	Many to many, many to one, one to many	Feeds rail transit system; dispatcher assigns passengers and routes; some package and telegram delivery
Ann Arbor, Michigan	3 peak, 3 off peak	10	30	1	Bus based, citywide	Many to few	Vehicle tour concept; dispatcher sequences pickups and deliveries; drivers self-routed
Bay Ridges, Ontario	4 peak, 2 off peak	11	44 peak, 22 off peak	1	Bus based, feeder	Many to many, many to one	Dispatcher assigns riders in groups; drivers self-routed; 20-min cycle (feeder); 30-min cycle (many to many)
Batavia, New York	5 peak, 3 off peak	23	115 peak, 69 off peak	1	Bus based, citywide	Many to many	Dispatcher assigns riders and routes; 20-min schedule; package delivery
Columbus, Ohio	4	19	76	3 peak, 1 minimum	Bus based, model city	Many to many	Fixed route with deviations; dispatcher assigns trips; drivers select exact routes
Haddonfield, New Jersey	14 peak, 10 off peak	13 to 17	210 peak, 130 off peak	3 peak, 1 minimum	Bus based, citywide	Many to many, many to one	Feeds rail transit system; continuous service (noncycle, continuous tours)
Regina, Saskatchewan	12 peak, 8 day, 2 night	14 to 23	228 peak, 152 day, 58 night	1	Bus based, feeder	Many to few, many to one	Integrated with transit system; 30-min tour (peak); 20-min tour (off peak); 40-min tour (nights and Saturdays)

Table 3. System comparison based on wage rates and productivity (5).

City	Driver Cost/Hour (dollars)	Average Fare (dollars)	Productivity (riders/driver h)			Percentage of Driver Salary Covered by Fare
			Needed to Cover Driver Costs	Average	Difference	
Ann Arbor, Michigan	5.50	0.45	12.2	7	-5.2	57
Batavia, New York	3.40	0.42	8.1	7	-1.1	86
Bay Ridges, Ontario	3.32	0.28	11.8	5	-6.8	42
Columbus, Ohio	4.50	0.25	18.0	8.8	-10.0	49
Haddonfield, New Jersey	5.63[a]	0.55	10.2	5.4	-4.8	53
Regina, Saskatchewan	6.00	0.32	18.7	19.5	-0.8	104
Davenport, Iowa	2.24[b]	1.05	2.1	4.1	+2.0	192
Hicksville, New York	2.37[b]	2.07	1.1	2.7	+1.6	236

[a]Does not include fringe benefits.
[b]Does not include tips. If tips are added, salaries would be higher.

dial-a-bus systems, however, operate over areas of 2.3 to 4.3 miles^2 (6 to 11 km^2). Only 1 public system served a larger area than the smaller private system. Consequently, trip length probably will be much greater and trip generators probably will be much more diverse for the private system. This greater length and dispersion will greatly increase deadheading, which will decrease the productivity of the system. In spite of the greater trip lengths and dispersion, the cost per ride of the taxicab service compared very favorably with the cost per ride of the dial-a-ride systems.

FLEET SIZE

One of the key factors in planning second-level transportation systems is the appropriate size of vehicles. Figure 1 shows a comparison of peak-hour demand density for the 2 types of systems. Fleet sizes in Davenport, Iowa, and Hicksville, New York, have been superimposed on the Arrillaga and Mouchahoir (4) graph. The Arrillaga and Mouchahoir report standardized vehicle data to adjust for various vehicle sizes. By averaging the capacity of the vans and the minibuses, Arrillaga and Mouchahoir developed an average vehicle capacity of 16.2 seats/vehicle. By using this method, Arrillaga and Mouchahoir indicated the number of 16.2-passenger vehicles needed to serve a given level of peak-hour demand. This approach works well where demand is highly concentrated and seat availability is the main criterion. The 2 taxicab companies that have capacities of 5 passengers per vehicle were superimposed on the graph.

Several points are obvious. The system in Davenport, Iowa, because of the very large area that it serves, is low on the peak-hour demand density of the scale. The system in Hicksville, New York, with lower ridership but a much smaller service area, has a greater peak-hour demand density per rider per mile^2 (kilometer^2). The private taxicab companies operate more vehicles per mile^2 (kilometer^2) than do the larger dial-a-bus systems. On an adjusted seat per mile^2 (kilometer^2) basis, however, they are very similar. The system in Davenport, Iowa, uses fewer seat miles (kilometers) than the dial-a-ride system does. That the taxi may not serve all areas equally but, rather, may concentrate more on certain parts of the community should be emphasized. Basically, however, the taxicab companies carry almost as many people per mile^2 (kilometer^2) over a larger geographic area as the dial-a-ride systems transport over very dense or small geographic areas.

The data given in Table 3 indicate that productivity per vehicle is lower for the 5-passenger taxicabs than it is for either the van or the minibus (2.7 riders/h for Hicksville, New York; 4.1 riders/h for Davenport, Iowa; 5.4 riders/h for Haddonfield, New Jersey; 5 riders/h for Bay Ridges, Ontario; 7 riders/h for Ann Arbor, Michigan, and Batavia, New York; and 19.5 riders/h for Regina, Saskatchewan). It is important to note, however, that figures for average ridership per driver hour are reduced for the taxicab systems because they provide service 24 h/day and 7 days/week even though no profit is made in the evenings when ridership is low. Also, the lower productivity is explained partially by the much larger service area, longer trips, and willingness to accept calls to low-density suburbs, which drastically cut the potential of ride sharing. Hence the private systems offer service that the public systems do not provide.

MARKET SHARE

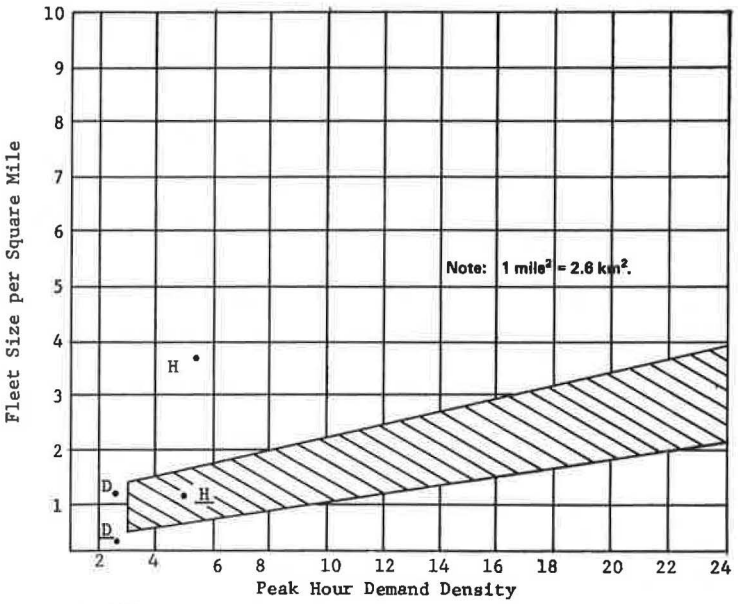
Figure 2 shows data that are a compilation of daily ridership figures as a percentage of the population that ride in each of the dial-a-bus communities. Superimposed on the graph is the range of average weekday ridership per 1,000 people for Davenport, Iowa, and Hicksville, New York. Both systems fall well within the dial-a-bus value. It must be remembered that the taxicab fares are from 2 to 8 times higher than the fares of the dial-a-bus system, yet they still attract a similar share of the rider market. This is interesting because there appears to be little difference in the demo-

Table 4. System comparison based on costs and revenue per ride (6).

Location	Cost per Ride (dollars)	Revenue per Ride (dollars)	Revenue Minus Cost (dollars)
Ann Arbor, Michigan	1.35[a]	0.45	-0.90
Batavia, New York	0.61[b]	0.42	-0.19
Bay Ridges, Ontario	0.60[c]	0.28	-0.32
Columbus, Ohio	—[d]	0.25	—
Haddonfield, New Jersey	3.50[e]	0.55	-2.95
Regina, Saskatchewan	0.70[c]	0.32	-0.38
Davenport, Iowa	0.58[f]	1.26	+0.68
	1.13[g]		+0.13
Hicksville, New York	0.89[f]	2.45	+1.56
	1.76[g]		+0.69

[a]Operating cost only.
[b]Includes debt service administration and overhead.
[c]Includes depreciation and overhead.
[d]Not available.
[e]Includes capital costs, depreciation, and overhead.
[f]Total cost excluding lessee's income.
[g]Total cost plus current lessee income.

Figure 1. Fleet size per mile^2 (kilometer^2) versus peak-hour demand density (4).



D = Davenport Unadjusted for Capacity
H = Hicksville Unadjusted for Capacity
D = Davenport Adjusted for Capacity
H = Hicksville Adjusted for Capacity

graphic characteristics of taxicab riders in Davenport, Iowa, and Hicksville, New York, and the traditional transit user in those cities (1).

OPERATING COSTS

Figure 3 shows a comparison of daily operating costs for the system. As would be expected, the average cost for the smaller vehicles (5-passenger taxicabs) is much lower than for the large vehicles (16.2-passenger vehicles) that Arrillaga and Mouchahoir used. Even if operating costs are adjusted to base cost on seat availability (3.2 taxicabs equal 1 average 16.2-passenger dial-a-bus), the taxicab operating cost is comparable on a daily basis. It should be remembered that the taxicab cost was based on a 24-h day; the other system cost was based on a shorter day (Table 1).

SUMMARY

In summary, this comparison of privately owned and operated shared-ride taxicab services and publicly owned and operated dial-a-bus systems identifies several areas that deserve further examination.

Both systems appear to be able to attract virtually the same market share in spite of the much higher fares charged by the taxicab companies, and, from preliminary analysis of these systems, the demographic characteristics of the 2 markets are similar.

The cost of providing the service is substantially higher for the public companies than it is for the private companies on either a vehicle or seat availability basis.

The publicly owned dial-a-bus systems apparently concentrate on relatively small geographic, high-density areas or otherwise limit their activity to transit feeder service. The cost structure of the taxicab system allows substantially greater flexibility in providing many-to-many service over wider areas and during low demand periods.

Productivity of the 5-passenger taxicabs appears to be slightly lower than productivity for the larger 12-to 23-passenger vehicles in a dial-a-bus system, but whether this was due to the longer trips and lower density trip generators in the taxi service areas or the capacity of the vehicles cannot be determined.

The operating cost of the publicly owned systems appears to be substantially higher than the market would dictate because the market provides an ample supply of skilled, licensed drivers. The publicly owned systems pay much higher salaries than comparably skilled workers would receive in industry; the salary structure of private companies more nearly reflects the market price. No investigation was made of the institutional factors that establish the higher wage rate.

The artificially high wage rate appears to severely restrict the flexibility of the service provided by the dial-a-bus system even though operating subsidies are allowed. These restrictions include range of operating area, hours of operation, size of vehicle used, and the ability to supply true many-to-many service.

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The contents of this paper reflect the views of the authors. The authors, not necessarily the sponsoring agency, are responsible for the facts and the accuracy of the data presented.

Figure 2. Daily and peak-hour ridership versus population (4).

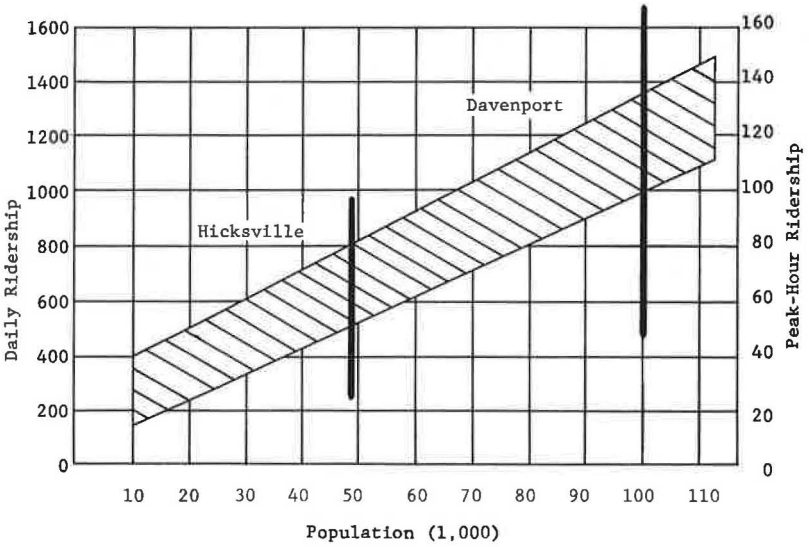
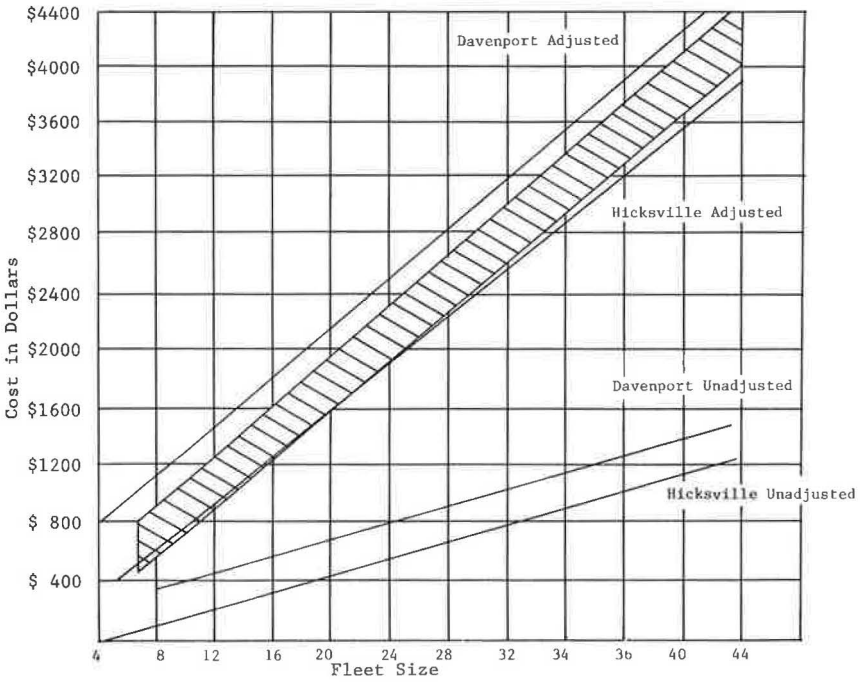


Figure 3. Daily operating cost versus fleet size (4).



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