

the mall were also in favor of continuing the bus mall. This group constituted 26 percent of the automobile users interviewed.

Less than 15 percent of the respondents perceived any one of the following conditions to be adversely affected by the mall: traffic congestion, noise, air quality, safety, convenience, speed, pedestrian circulation, and the general CBD environment. The mall's impact on safety and congestion received the highest proportions of positive responses; the impact on the general environment and on pedestrian circulation received the lowest proportions of adverse reactions. Noise and air quality were perceived most often to be unaffected by the transit mall. Speed and convenience received mixed reactions.

Chi-square tests showed that, at the 0.05 level of significance, trip purpose and arrival time explain the differences in the respondents' perceptions of the mall's impact on congestion and safety. The mode of travel to the CBD made a difference in the perceived effects that the mall had on convenience and speed.

These findings should be useful to urban transportation planners and decision makers because they may represent a movement of public attitudes in the direction of favoring the preferential treatment of high-occupancy vehicles, in general, and urban bus systems, in particular.

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REFERENCES

1. Central Business District East-West Transportation Corridor Study. Department of Transportation Services, city and county of Honolulu, technical rept. RT-78-01, Aug. 1978.
2. The State of Hawaii Data Book. Department of Planning and Economic Development, Honolulu, 1978.
3. Hotel Street Bus Demonstration. Department of Transportation Services, city and county of Honolulu, technical rept. TP-78-02, July 1978.
4. N. H. Nie and others. Statistical Package for the Social Sciences, 2nd ed. McGraw-Hill, New York, 1975.

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Recent Experience with Accessible Bus Services

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Fixed-route, standard-sized buses equipped with level-change mechanisms to transport wheelchair or semiambulatory passengers between the ground and the bus floor level are currently in service in 23 locations in the United States. This paper includes a brief description of the services in place and a discussion of experience with their operation. Data are limited due to the newness of many of the services and the fact that few transit operators collect the kind of information that is most useful for evaluation. Available data have been collected to inform planners and operators of future accessible bus services of the policy issues and operational impacts they probably will face and the level of ridership they initially can expect. A few findings can be stated: (a) Lift reliability has improved substantially through the emergence of new lift designs and modifications to existing models and (b) ridership continues to be low, with most transit operators reporting between one and three lift-assisted boardings per day. Most of these trips are taken by a few regular riders. The economic impact varies considerably among operators, depending on the reliability of the particular model of lift operated and whether schedule changes were instituted specifically for implementation of the accessible buses. At current lift-utilization rates, accessible bus service will not significantly affect transit operations.

The past year has seen some major developments in the area of fixed-route accessible bus service that uses standard-sized buses. This type of service has been initiated by 18 more transit authorities, which makes a total of 23 now in operation. Three new level-change devices

(most often called lifts) are now being used in service. The Transbus concept, which the U.S. Department of Transportation (DOT) thought would be the solution to fixed-route bus accessibility, received a setback when bid solicitations for the bus produced no respondents. The National Research Council review panel concluded that Transbus, as specified in the solicitation, could not be built without considerable technical and financial risk on the part of the manufacturers (1). Also, DOT issued regulations to implement Section 504 of the Rehabilitation Act of 1973, which (among other provisions) mandated the purchase of accessible buses for every bus ordered after July 2, 1979. These regulations are currently being challenged in court by the American Public Transit Association (APTA).

In spite of the number of accessible bus services that are operational, a wealth of data is still not available. The prime reason for this is that the collection and analysis of the type of information most useful to policy-makers and other transit operators require a substantial evaluation effort, an undertaking that is beyond the fiscal resources available to many transit properties. Consequently, the most detailed information about accessible services will continue to be disseminated through the Urban Mass Transportation Administration (UMTA) Ser-

vice and Methods Demonstration (SMD) program.

ACCESSIBLE SERVICES

The 23 accessible fixed-route services in operation by December 1979 are summarized in Table 1. The number of accessible buses available at these locations totaled 1239, although only 759 were scheduled to be in service at that time.

In addition, a number of accessible buses are on order from the two U.S. manufacturers of advanced-design buses [Grumman-Flxible and General Motors Corporation (GMC)] and the Canadian manufacturers of new-look buses (General Motors of Canada and Flyer Industries). Accessibility has been and will continue to be achieved primarily in connection with new bus purchases.

IMPLEMENTATION ISSUES

The implementation process requires policy decisions about the following:

1. Whether to institute schedule changes,
2. What to do about reduction in seating capacity,
3. How much driver assistance to permit, and
4. Who will be allowed to use the lift.

A few transit operators made operational changes in anticipation of potential delays in running time caused by wheelchair boardings and alightings. However, the low ridership by wheelchair users has indicated that such action would not appear necessary. Most operators have not made operational changes but are observing the operations closely to determine whether the delays experienced significantly disrupt normal operations on the accessible routes. Changes may be made later if service is seriously affected.

Several operators are concerned by the loss of regular seating capacity due to the provision of wheelchair tiedowns on the accessible buses. The majority of tiedowns take away two regular seats per tiedown position.

Four operators have added buses and decreased headways to compensate for this and for the seats lost due to the smaller seating capacity of the advanced-design buses. Extra buses probably would not be added solely due to the loss of seats in the tiedown areas.

Driver assistance to severely mobility-limited passengers is either not permitted or discouraged by nine transit operators. In those situations, potential passengers may be inhibited from using the bus service if they encounter or fear difficulty in using the lift or the tiedown devices.

Seven of the operators have taken the position that only persons in wheelchairs will be allowed to use the lift due to a concern about potential injuries and accident claims from lift standees. In current lift-equipped buses, headroom clearance at the door frame is restricted for persons who stand on the lift.

TRAVEL BEHAVIOR

Surprisingly, accessible-bus-ridership data about wheelchair users are not always available or accurate. Only about one-half of the operators are able to supply what they consider reasonably accurate ridership totals. In spite of the data limitations, ridership figures are presented for every locale for which figures are available.

Ridership Data

San Diego Transit Corporation (SDT) operates accessible bus service with five buses (four scheduled) on two routes. SDT reported an average of 41 wheelchair-passenger trips/month during 1978. In view of the small number of accessible buses used, this is relatively high compared with most of the transit properties. According to SDT, four people are regular riders. The 1978 ridership was about double the monthly ridership totals of 1977. No figures are yet available for 1979.

The Southeastern Michigan Transportation Authority (SEMATA) now has 61 (50 scheduled) buses that operate on nine (seven fully accessible) routes. Virtually all transit

Table 1. Accessible bus service characteristics.

Location	Initial Service Date	Manufacturer		Accessible Buses ^b			Fleet Accessibility (%)	Recent Lift Uses per Month
		Bus	Lift ^a	On Prop-erty	Scheduled	No. of Routes Accessible ^{b,c}		
San Diego	2/77	GMC ^d	TDT	5	4	2 P	1	41
St. Louis	8/77	Flxible	TDT	157	41	12 P	15	30 ^e
San Mateo	9/78	AMG	TDT	24	15	2 P	11	30-40 ^f
Detroit (SEMATA)	10/78	GMC ^e	GMC	61	50	7 F, 2 P	18	40-50 ^f
Santa Clara	12/78	Gillig	TDT	52	21	3 F	27	NA
		GMC ^e	GMC	58				
Fayetteville	12/78	GMC ^e	GMC	6	6	6 P	23	7
Gardena	12/78	GMC ^e	GMC	2	1	1 P	6	NA
Rhode Island	1/79	GMC ^e	GMC	19	15	5 P	9	81 ^g
Westchester	3/79	GMC ^e	GMC	105	91	8 P, 2 F	42	NA
Hartford	4/79	Flxible ^h	EEC	155	140	26 P	56	38
Rock Island	4/79	GMC ^e	GMC	7	6	6 P	23	<1
Milwaukee	4/79	Flxible	Vapor	100	62	6 P	17	21
New Haven	6/79	Flxible ^h	EEC	100	90	18 P	83	43
Janesville	6/79	GMC ^e	GMC	10	7	7 P	53	100
Washington	7/79	Flxible	Vapor	150	93	34 P	8	150 ^g
Montebello	7/79	GMC ^e	GMC	8	6	2 P	22	0
Ventura	7/79	GMC ^e	GMC	2	1	1 P	5	6
Detroit (DDOT)	9/79	GMC ^e	GMC	163	26	1 corridor F	20	2
Stamford	9/79	Flxible ^h	EEC	35	28	13 F	100	10-15 ^g
Seattle	9/79	Flyer	Lift-U	50	27	6 F	7	100+ ^g
Colorado Springs	9/79	GMC ^e	GMC	14	0 ^f	9 P	37	80 ^g
Palm Beach	10/79	GMC ^d	TDT	15	3	1 F	25	28
Los Angeles	11/79	AMG	TDT	28	11	1 P	NA	NA

^aTDT = Transportation Design and Technology, Inc.; EEC = Environmental Equipment Corporation.

^bAs of November 1979.

^cP = partially accessible; F = fully accessible.

^dRetrofitted buses.

^eAdvanced design buses.

^fPublished schedules do not indicate accessible buses.

^gEstimated.

trips by wheelchair users are made by two persons who transfer from a dial-a-ride service to the accessible fixed-route buses. SEMTA estimates that these two riders take about 40-50 bus trips/month.

The San Mateo County Transit District (SAMTRANS) operates 24 (15 scheduled) accessible buses on two routes. SAMTRANS estimates that ridership by lift users averaged 30-40 one-way trips/month from July to September 1979. Usage has dropped off somewhat since the end of 1978. SAMTRANS' continuing lift-reliability problems have undoubtedly affected ridership. SAMTRANS reports that (a) the majority of lift users are persons in wheelchairs, (b) three wheelchair users take most of the recorded trips, and (c) these three users transfer from a dial-a-ride service to the accessible buses.

The Bi-State Development Agency scheduled 126 of their 157 accessible buses in daily service over the period November 1977-August 1978. However, since the actual availability of accessible buses was generally far short of the required number, Bi-State cut back the number of scheduled buses to 40 in September 1978.

A total of 60 unduplicated users of Bi-State's accessible service were identified during the nearly two-year evaluation period. Only 13 wheelchair users made more than 10 one-way trips on the buses, which represents 82 percent of all trips reported. Ridership has been highly variable, due in part to weather conditions as well as equipment reliability problems and the service cut-back. Recent totals have been about 30 boardings/month.

In Fayetteville, North Carolina, the transit operator schedules all six of the accessible buses in service, one on each of the six routes. Since on an average day one of these vehicles is out of service, missed runs are a common occurrence. Since July 1979, when ridership counts were begun, boardings averaged 6/month.

The Rhode Island Public Transit Authority (RIPTA) has had 19 accessible buses (15 scheduled) in service since January 1979. Over the following six-month period, 45 wheelchair trips were recorded, or an average of 8 boardings/month. However, expansion of a one-week count in November would result in a monthly total of 81 boardings. RIPTA indicates that most of the trips counted in the November sample week were taken by three persons.

Milwaukee Transport Services operates 100 accessible buses (55 scheduled) on six routes. Ridership built up to approximately 50 boardings/month during the summer, but dropped off to less than 10 in October and November. They estimate that 80 percent of the trips are made by four or five persons.

Connecticut Transit operates 100 (90 scheduled) accessible buses in New Haven. Each of their 18 regular routes are partially accessible during the peak periods and virtually 100 percent accessible during the off peak. Lift users made an average of 43 boardings/month from August to October 1979.

In Hartford, Connecticut Transit schedules 140 of their 155 accessible buses. All of their routes are partially accessible during the peak periods and almost fully accessible during the off peak. Ridership, which has been somewhat erratic, averaged 38 boardings/month from September to November. Nearly twice that number used the service in August.

In Stamford, Connecticut Transit has operated a fully accessible, 35-bus (28 scheduled), 13-route system since September 1979. November was the first month in which any lift users were carried. The operator estimates that 10-15 lift-assisted boardings were made during that month.

The Janesville (Wisconsin) Municipal Bus System has averaged more than 100 lift-assisted boardings/month

from July to November 1979 on their 10 accessible (7 scheduled) buses. One daily rider accounts for almost one-half of the trips. There are four or five other occasional riders.

Rock Island County (Illinois) Metropolitan Mass Transit District has carried only two wheelchair passengers in seven months of operations on their seven (six scheduled) accessible buses. However, except for printed schedules and contracts with social service agencies, there has been little marketing or advertising of the service.

The Washington Metropolitan Area Transit Authority (WMATA) has recently expanded its accessible bus service to 150 (93 scheduled) buses that operate on 34 routes. WMATA estimates 150 wheelchair-user boardings/month based on the known travel patterns of some regular riders.

The Santa Clara County Transportation Agency's recently delivered advanced-design buses have not yet been put into service. At this time, only 21 of their 110 accessible buses are scheduled for three routes. Sample counts were made on a few days in January, February, and March of 1979 on the two routes then in service. An average of 19 lift-assisted boardings were recorded on those days, 9 of them by nonwheelchair users.

Montebello Municipal Bus Lines have carried only one lift user in the early months of operations of their eight (six scheduled) accessible buses.

South Coast Area Transit in Ventura, California, schedules one of their two accessible buses on an hourly headway on their heaviest route. They have averaged 6 boardings/month of wheelchair users.

The city of Detroit Department of Transportation (DDOT) has not yet placed their 122 new accessible buses in service. Consequently, they still operate only 41 (26 scheduled) buses in one fully accessible corridor. In the short period of operation, boardings by wheelchair users have averaged only about 2/month.

Seattle Metro currently schedules 27 of their accessible buses on six routes. Four of these routes began in November. A total of 153 accessible buses will be on the property when delivery of the current order is completed in February. Accessible trolley buses have also been ordered. The six accessible routes have attracted three regular commuters plus a few other occasional riders. Metro estimates that boardings will exceed 100/month.

In Colorado Springs, Colorado Transit Management, Inc., operates 11 or 12 of their 14 accessible buses on their nine routes. However, the accessible bus trips are not yet noted on schedules. In spite of the lack of schedules, the transit operator estimates that wheelchair user ridership totals were about 80 during November.

The Palm Beach County Transportation Authority began accessible bus service in October with 3 of their 15 retrofitted vehicles. One route has been made fully accessible. During the month of October, 28 lift-assisted boardings were recorded. This dropped to 6 in November.

The Southern California Rapid Transit District (SCRTD) in Los Angeles is operating an accessible bus demonstration route that uses 11 scheduled accessible buses. SCRTD has made a special effort to get wheelchair users to ride the line so that they can assess the operational impacts and make appropriate operational changes, if needed, in routes to be made accessible later. During the first few weeks of service, 17 lift-assisted boardings were recorded, 11 of them on one day. However, this is not indicative of ridership to be expected in regular, accessible service.

Summary

As can be seen from Table 1 and the above discussion, ridership by persons who need the lift to board buses has been low. On the other hand, to date, generally only a portion (often small) of the buses at a transit property are accessible, and many of them have been in service for only a few months. The changes in demand in response to increases in the supply of accessible service is a relationship that will be watched with considerable interest. In those instances where the same number of accessible buses has been in operation for six months or more, there has generally not been a continuing increase in ridership.

There are a number of possible reasons for the lack of significant ridership increases. Equipment problems are one of these. Severe winter weather will certainly inhibit travel by wheelchair users. Restrictions placed on driver assistance to wheelchair passengers by some transit authorities may also be a factor that tends to depress ridership. Without the assistance of either the driver or another passenger or companion, some wheelchair users may be unable to use the bus. It is also quite possible that more time is needed for the target population to change their travel habits or patterns and switch to use of the accessible buses.

Very few data are available concerning reasons why more of the target population do not ride the accessible buses. Results from a survey of 60 wheelchair users in St. Louis who had not ridden the accessible buses are presented below; the ratings are based on a scale in which 1 = least important and 5 = most important:

Reason for Not Using Buses	Average Rating
Do not need them—have other transportation available.	3.5
I cannot go out at all without help.	3.5
Lack of curb-cuts near my home or my destination.	3.1
It is too difficult for me to travel on sidewalks or roads to reach the bus stop.	2.8
Bad weather such as rain, snow, or cold.	2.5
Accessible routes do not go near my residence.	2.2
Bus transportation takes too long or is too inconvenient compared to a car.	2.2
Accessible routes go near my home but do not go near my destination.	2.1
Cannot get on the bus lifts very easily.	2.1
Trouble obtaining the schedule of accessible buses.	2.0
Cars parked in bus stop.	1.9
Lifts are unreliable and sometimes do not work.	1.7
Afraid to use—heard bad things.	1.7
The buses are unreliable and do not keep to the published schedule.	1.6
Do not feel safe on the lifts or on the buses.	1.5
Buses are too crowded when I want to use them.	1.5
Do not like going out in public.	1.4

The reasons for nonuse that received the highest ranking were the difficulty of going out at all, the difficulty of getting to or from the bus stops, the availability of another mode of travel, and weather. These answers give evidence that fixed-route accessible buses will only be a feasible alternative for a portion of the target population.

For other segments of the handicapped and elderly populations, the situation is less clear. Little is known about the potential benefits of accessible buses to the elderly and nonwheelchair handicapped. The number of nonwheelchair users who would actually use transit because lifts or other accessibility aids are provided would be difficult to determine.

LIFT EQUIPMENT

Five different wheelchair lifts have been installed by bus manufacturers in standard-sized buses for use in regular fixed-route transit service. The manufacturers of these lifts are Transportation Design and Technology, Inc.; Vapor Corporation; General Motors Corporation; Environmental Equipment Corporation; and Lift-U, Inc. A sixth lift, manufactured by Transi-Lift Equipment Ltd., has only been installed for testing purposes.

Reports from the operators indicate that all lifts have some deficiencies or drawbacks. As deficiencies have surfaced, lift manufacturers generally have been responsive in making modifications to improve performance. As a consequence, the current models are considerably more reliable and usable by the passengers than they were one year ago. It seems reasonable to expect further lift reliability and performance improvements in the years ahead.

Operations

Even though the state of the art in lift technology is advancing, a few transit authorities continue to have difficulty in always providing an accessible bus in accordance with the published schedules. The extent to which this situation prevails will depend, in part, on the number of accessible buses retained as spares. As noted previously, lift reliability has improved considerably. St. Louis no longer reflects the current status of wheelchair lift performance. A couple of transit operators reported that the lifts themselves work quite well but that many of the problems are caused by driver mistakes.

The availability of accessible vehicles can also be affected by their heavy use. These buses are operated more than are nonaccessible buses due to their constant use in both peak and off-peak periods. Consequently, they require more frequent maintenance and repair than do other vehicles. As a result, a larger number of spare lift buses are probably required for schedule adherence than are normally required for the rest of the fleet. This would vary for lifts produced by different manufacturers.

The added workload for maintenance of the lifts has resulted in an increase in the maintenance staff in St. Louis, Milwaukee, Hartford, Washington, Santa Clara, New Haven, Stamford, and Detroit. It seems likely that extra maintenance personnel will be needed by all transit properties that implement any significant amount of accessible bus service.

The potential for through-routing may be restricted or placement of the accessible buses may be complicated if the transit system is only partially accessible. If through-routing is reduced, greater bus service hours should result. It is not known how much through-routing reduction has occurred.

Four transit operators have added buses on accessible bus routes to compensate for seats lost in the wheelchair tiedown positions and due to the smaller seating capacity of the new buses. Buses probably would not be added for the provision of tiedowns alone.

Buses will be delayed whenever wheelchair passengers are carried. The average time for wheelchair users to board and tie down will probably average 2.5-3 min. The average alighting time is about 1 min less than the boarding time. For each wheelchair passenger, the delay would average 4-5 min.

Some transit operators are forced by state laws to operate the narrow, 264-cm (96-in) wide buses. If the lift is installed in the front door of these buses, wheelchair users often find it very difficult to maneuver once inside. This would result in a longer dwell time at the

stop. If the lift is installed in the rear door of the bus, the maneuvering problem is removed, since the tiedown positions can be installed directly across from the door. The drawbacks to this lift location are that the driver has to go to the rear of the bus to operate the lift, and maneuvering the bus so that the rear door is adjacent to the curb is not always easy.

Costs

Capital costs incurred will consist primarily of the cost of the lift equipment and wheelchair tiedown devices. The cost of different lifts plus tiedowns on new bus orders prior to the effective date of Section 504 regulations ranged from \$8500 to \$14 000. Since all buses ordered now must be accessible, the price of the lifts and tiedowns are usually not separated from the total price of the bus and, consequently, are difficult to identify. Retrofits of existing buses would probably cost about twice that of new buses.

In addition to capital costs, accessible bus service will incur increased operating costs. These include the cost of any schedule changes, through-routing reduction, staff time, extra mechanics, driver training, promotion and advertising, accident claims (if any), and extra drivers' pay (if any).

Transit operators who reduce headways to compensate for seats lost in providing wheelchair tiedown positions may incur substantially increased operating costs. SEMTA states that each extra bus costs them \$60 000-\$70 000/year.

Extra mechanics have been hired by several properties to work on the lifts. Each extra mechanic would probably cost \$15 000-\$20 000/year.

The amount of driver training given has varied from 0.5 h on lift operation to 10 h, including sensitivity training on the problems of the handicapped. At most properties, drivers are paid extra for attending these training sessions, often at overtime rates. All drivers at each site are normally given this training. Refresher training may also be necessary in some cases.

The amount of promotion and advertising of accessible bus services has varied considerably. Some have used television, radio, and newspapers and have conducted field demonstrations, while a few have done little more than publish schedules that note the accessible bus trips. Bi-State, which had an extensive radio and newspaper advertising campaign, spent approximately \$35 000 during the first year of operations.

To date, two operators have reported accident claims due to lift operations. Specific accident-claim data are not available at this time, but most of the claims have been small.

Only in Detroit has lift operation been a major labor issue. The issue was resolved by DDOT when it agreed to pay the drivers \$0.50 for each time they operate the lift for a wheelchair passenger. At both SEMTA and DDOT, the minimum layover time was increased by 5 min for accessible buses. The only other known instance

where drivers are paid extra for operating accessible buses is in Rhode Island, where they are paid 5 min extra time for cycling the lift before leaving the garage each day.

OTHER IMPACTS

The impact on transit travel time of nontarget group riders will be minimal if wheelchair ridership remains low. Lift operation for two or more passengers during a single bus run would delay other riders and bus operations significantly. This is unlikely to happen with any regularity in the near future.

In order to install wheelchair tiedown positions in the buses, regular seats are usually removed. A level of service change would occur for any riders forced to stand due to the loss of seats.

Accessible bus operations have resulted in a few passenger injuries. The majority of these injuries were caused by persons who fell while boarding or alighting. Four injuries involved wheelchair users.

FINDINGS

The majority of transit authorities that operate fixed-route accessible buses have made no changes in operating procedures or schedules specifically for the implementation of accessible buses. Wheelchair-user ridership has ranged from fewer than one to a little more than three one-way trips per day. Most of the transit trips by wheelchair users are made by a few persons who are fairly frequent riders. Therefore, although accessibility to bus transportation is being improved, the overall mobility of the target population has changed very little as a result of accessible bus service.

Advances in lift technology have improved their performance substantially. As a consequence, lift maintenance expenditures are much less than for earlier models. For most transit operators, the added costs of accessible bus operation will consist principally of the capital cost of equipment, staff planning time, maintenance of lifts, driver training, and promotional expenditures.

The preliminary evidence from recent implementations of accessible bus service indicates that, at current ridership levels, this service concept will not have significant impacts on transit service operations, regular transit riders, or other providers of service to the handicapped. This would not hold true if lift use increases dramatically.

REFERENCE

1. NRC Transbus Study: Part 1—Transbus Procurement. Commission on Sociotechnical Systems, National Research Council, NRC-CSS Special Rept., Aug. 31, 1979, pp. 1-38.

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