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# Fare Changes and Prepaid Pass Programs: Honolulu's Experience

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This paper documents Honolulu's efforts to establish a prepaid bus pass program at the time of a major fare increase. It also discusses the revenue-forecasting techniques used for estimating fiscal impact of change in fare structure. A comparison of the forecasted values with the results of the actual fare structure change is also presented. In FY 1980, the Honolulu bus system carried more than 60 million passengers and used about 300 buses. The system coverage is more than 95 percent of the island population of approximately 720 000. On November 1, 1979, the basic cash fare of \$0.25 was increased to \$0.50. At the same time, the sale of prepaid monthly bus passes was initiated with the basic cost of \$15.00; this significantly reduced the impact of the fare increase on frequent riders. As a result, the system did not experience any noticeable reduction in patronage. The average monthly revenue of \$850 000 for FY 1979 has increased to a current level of \$1.5 million. The system's major objective of increasing revenue was successfully accomplished without significant economic impact to the system riders. This was accomplished through the combination of fare increase and the initiation of discount prepaid passes.

On November 1, 1979, the City and County of Honolulu instituted a bus pass fare program and an increased fare schedule for its bus operation, TheBUS. The purpose of the fare program was to increase fare revenues to offset rising operating and maintenance costs. This paper documents Honolulu's efforts to establish a prepaid bus pass program at the time of a major fare increase. The paper also discusses the revenue-forecasting techniques used for estimating the fiscal impact of the fare structure change.

## BACKGROUND

In 1967, the Hawaii state legislature authorized Hawaii's four counties to own, operate, and maintain mass transit systems. The City and County of Honolulu established bus service in the rural areas of Oahu not covered by private mass transit carriers in 1969. Three months following a strike by the employees of the private mass transit carrier in urban Honolulu, the city initiated urban Honolulu bus service in March 1971 with 67 buses. During a 10-month period, the 67-bus fleet carried some 17 million riders. Over the last eight years, the city's system has grown rapidly in terms of level of service and area served. In FY 1980, the Honolulu bus system carried more than 60 million passengers using about 300 scheduled buses. The system covers more than 95 percent of the island population of approximately 720 000.

Total passengers using the bus system grew from 54 300 000 in FY 1975 (July-June) to 68 800 000 in FY 1979--a 37 percent increase during this period. Revenue vehicle hours increased by only 21 percent, most of which occurred between 1975 and 1976 (1). Ridership gains were considerably greater than the increase in service provided.

Operating expenses grew from \$14 900 000 in FY 1975 to \$29 500 000 in FY 1979, a gain of 98 percent. Since the system's average fare per total

passenger remained nearly constant during this interval, the operating deficit went from \$6 900 000 in FY 1975 to about \$19 500 000 in FY 1979, an increase of 183 percent.

On November 1, 1979, the basic cash fare of \$0.25 was increased to \$0.50. At the same time, however, the sale of monthly bus passes was instituted; this significantly reduced the impact of the fare increase on frequent riders.

## PAST FARE STRUCTURE

The fare structure for the bus system in Honolulu has traditionally been low. It is noteworthy that student fares decreased in 1971 after the city and county assumed control over the bus system.

Until March 15, 1974, Honolulu's bus system had a system of zone fares. In large part, these zones were carryovers from the private operators' policies. In 1973, the bus fares in Honolulu were as follows:

Item	Fare (¢)		Leeward Bus Co.
	City and County Buses Zone 1	Zone 2	Four Zones
Adult	25	50	15-60
Student	10	25	20-35
Child	10	25	-

Leeward Bus Company operated on a four-zone system until the termination of their operation in March 1974. This zone fare structure was eliminated to provide more equitable fares and service to all residents on Oahu.

Free bus passes for senior-citizen and ambulatory handicapped riders began in February 1970 and July 1976, respectively. These users can ride the bus system at all hours of operation at no charge. This policy is currently in effect. A curb-to-curb Handi-Van service was established in June 1977. The initial one-way fare was \$0.50/ride.

## PROGRAM DEVELOPMENT

Several studies were made to determine feasible alternatives for obtaining additional funding and revenue to offset increased operating and maintenance costs of TheBUS. The first study was a bus passenger survey that sought to elicit bus rider's perceptions on increased bus fare options and on other funding alternatives. The second study involved an analysis of funding and fare options to determine the fiscal impact of a proposed subsidy limit considered by Honolulu's City Council.

### Bus Passenger Survey

The bus passenger survey was conducted during the summer of 1978 (2). About 4000 questionnaires were distributed and collected on all the bus routes and at selected bus stops. A return of 3593 survey forms was achieved and represented 2.1 percent of the daily bus ridership (170 000 riders) at that time. Findings of the study include the following:

1. Almost one-half of the bus riders were in favor of raising fares. The express routes had the largest percentage in favor of a bus fare increase.

2. Of those in favor of raising fares, about 50 percent chose the new fare at \$0.35. More than 50 percent of those people who favored an increase on the suburban and shuttle routes chose \$0.35 as the new rate. About 40 percent of those passengers who favored raising fares on the express buses selected a fare increase to \$0.50. The weighted average of those in favor of an increase was \$0.41. About twice as many people who indicated they were in favor of an increase chose \$0.50 over \$0.40, probably due to the convenience of carrying fewer coins. About 29 percent of the total number surveyed were willing to pay \$0.35, while 14 percent favored a \$0.50 bus fare.

3. About 47 percent were in favor of reallocating taxes to help pay for operating the bus system. The results of the bus survey illustrated that just as many people were in favor of a tax reallocation as were opposed. Of those who favored using additional taxes to help pay for operating the bus system, the hotel room tax was selected by 56 percent. Gasoline and vehicle weight taxes were selected by approximately 25 percent.

4. An analysis of rider response regarding satisfaction with current bus service indicated a 3-to-1 average rate of satisfaction. People surveyed at the bus stop were more inclined to indicate dissatisfaction with the bus service, over a 3 to 1 yes/no ratio. The express riders surveyed were the least satisfied (67 percent).

### Funding and Fare Options

A second study was undertaken concurrently with the bus passenger survey to investigate the feasibility of raising fares, increasing vehicle weight taxes, and gasoline and property taxes to cover growing bus deficits (3).

In addition, several fare structures were investigated by the city. After reviewing the various potential fare structures with the findings of the bus survey and the pass programs of two other transit properties, the Department of Transportation Services proposed a bus pass program (3).

Based on the review of Seattle's Metro System (4) and the Southern California Regional Transit District (5), the following advantages of a bus pass program were cited to justify such a program.

1. The pass is convenient and easy to use.
2. Riders never have to bother with having correct change.
3. The pass can easily become a bargain because it can be used as often as desired within the prescribed period (proposed Honolulu pass holders will break even with 30 rides).
4. It simplifies passenger loadings, thus increasing bus speeds especially during heavily used peak hours.
5. Daily cash accounting would be reduced.
6. Cash flow would improve by advanced monthly payments.

### PATRONAGE AND REVENUE ESTIMATES

The Simpson-Curtin rule was considered for making patronage estimates resulting from fare increases. Three features of the Honolulu system, however, precluded the use of the formula:

1. Captive transit riders, the elderly and handicapped, ride free at all times on the Honolulu system. Therefore, this group would not be affected by any fare changes.

2. The basic Honolulu transit fare has not been changed since 1961, while the annual average consumer price index has risen from 88.6 in 1961 to 169.4 in 1977 (base: 1967 = 100), an increase of more than 90 percent. Therefore, transit users may perceive the increase at a lower rate than the actual percentage.

3. A one-time flat fare is charged in the present and proposed system regardless of the length of a route or type of service (trip length varies from the shortest shuttle to the approximately 4-h, 90-mile around-the-island route). It is difficult to assume that the impact of a given fare increase is independent of trip length.

The general method selected was similar to a variation of the Delphi method used by Seattle (4).

The procedure used to estimate patronage and revenue under the proposed fare structure and bus pass program is charted in Figure 1. The procedure is summarized below.

1. A base ridership is established assuming current conditions (existing fare structure and no bus pass program).

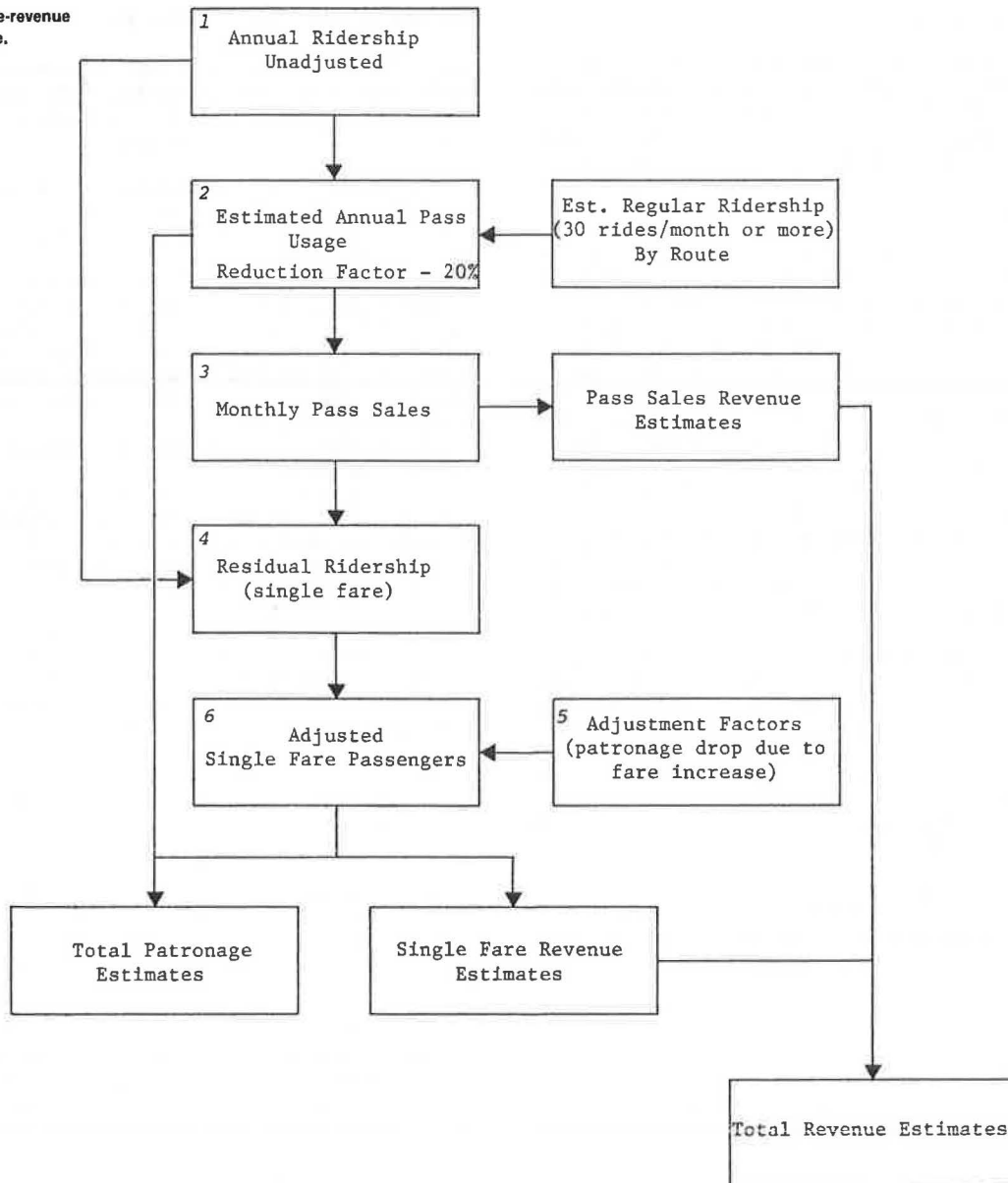
2. It was assumed and agreed on by a group of transit experts that, since the monthly bus passes would require 30 rides to break even with proposed single fares, a majority (80 percent) of regular bus riders--those who use the buses more than 30 times a month--would purchase the passes. These factors of regular bus users were applied to FY 1978 patronage by route to estimate annual potential pass users. The total was then adjusted for user irregularities by a reduction factor of 20 percent to yield an annual total bus-pass usage estimate (Table 1).

3. Pass sales were estimated on the basis of an assumption of 40 rides per month or 480 rides per year: 15 302 400 annual adult pass trips = 31 880 passes/month; 7 756 500 annual student pass trips = 16 160 passes/month. An annual pass sales revenue estimate for adults was made at \$15.00/pass for 12 months per year: 31 880 x (\$15.00) x (12 months/year) = \$5 738 400. Student pass revenue was estimated at \$7.50/pass for 12 months with a seasonal adjustment factor of 90 percent: 16 160 x (\$7.50) x (12 months/year) x (90 percent) = \$1 308 960. Student passes would be available for the full 12 months per year to accommodate the overlapping terms of private and summer schools and to increase the mobility of youngsters seeking employment or recreation.

4. The total annual base patronage minus the estimated pass usage is considered as the potential single fare-paying passengers.

5. Transit operation consultants and other transit experts were asked for their opinions for percentage reductions (shrinkage) of the single fare-paying passengers due to the proposed fare increases. Their responses on the estimated value varied from the lowest of no shrinkage to the highest of 15 percent for adult passengers but generally agreed on a 5 percent shrinkage factor. For the impact on student riders, a consensus opinion was a 5 percent reduction. However, in

Figure 1. Patronage-revenue estimates procedure.



rural Oahu where the school bus service is available at \$0.10/ride, the reduction was estimated between 40 and 50 percent.

Four patronage-revenue scenarios were made based on varying base patronage and shrinkage factors combinations. All scenarios were analyzed by using the proposed fare structure. Two base-paying patronages were used, 47.5 million and 50 million adults and students. The former represents a conservative estimate and assumes the same patronage as occurred in FY 1978. The latter represents a liberal patronage estimate. Two sets of shrinkage factors were used: (a) conservative estimate--adults, 15 percent; students, 50 percent; and other students, 5 percent; and (b) probable estimate--adults, 5 percent; students, 40 percent; and other students, 5 percent.

The four scenarios analyzed are as follows: (a) base-paying patronage, 47.5 million; shrinkage factors, conservative estimate; and bus pass program, yes; (b) base-paying patronage, 47.5 million; shrinkage factors, probable estimate; and bus pass program, yes; (c) base-paying patronage, 50 million;

shrinkage factors, probable estimate; and bus pass program, no; and (d) base-paying patronage, 50 million; shrinkage factors, probable estimate; and bus pass program, yes.

6. The adjustment or shrinkage factors were applied to the nonpass riders to obtain patronage-revenue estimates for this group. These estimates reflect the decrease in single-fare patronage due to an increase in fares. The results of the four scenarios with the shrinkage factors are presented in Table 1. Under the low estimate (high shrinkage factors and low patronage figure), with the proposed fare structure and bus pass program, revenue is projected to be \$15.7 million. If the most likely shrinkage factors were used with the low patronage figure, revenue is expected to increase to \$16.7 million. Assuming 50 million revenue passengers, the proposed fare structure, the most likely shrinkage factor, and no bus pass program, revenue would be \$19.5 million. By using a pass program, this estimate decreases to \$17.6 million. The range between the four scenarios is \$3.8 million.

Table 1. Patronage, revenue, and monthly-pass sales estimates for proposed fare structure.

Type	FY 1978				50 Million Revenue Passengers			
	Low Estimate				No Pass			
	Passengers	Revenue (\$)	Passengers	Revenue (\$)	Passengers	Revenue (\$)	Passengers	Revenue (\$)
Patronage <sup>a</sup>								
Adults	32 462 900	8 115 700	32 462 900	8 115 700	34 156 000	8 539 000	34 156 000	8 539 000
Students	15 058 800	1 505 900	15 058 800	1 505 900	15 844 000	1 584 400	15 844 000	1 584 400
Total	47 521 700	9 621 600	47 521 700	9 621 600	50 000 000	10 123 400	50 000 000	10 123 400
Pass usage								
Adults	15 302 400	5 738 400	15 302 400	5 738 400	0	0	16 100 300	6 037 600
Students	7 756 500	1 309 000	7 756 500	1 309 000	0	0	8 160 900	1 377 200
Total	23 058 900	7 047 400	23 058 900	7 047 400	0	0	24 261 200	7 414 800
Single fare <sup>b</sup>								
Adults	14 570 200	7 285 100	16 284 300	8 142 200	32 448 000	16 224 000	17 152 900	8 576 500
Students	5 666 000	1 416 500	5 946 500	1 486 500	12 961 000	3 240 000	6 267 700	1 566 900
Total	20 236 200	8 701 600	22 230 800	9 628 700	45 409 000	19 464 000	23 420 600	10 143 400
Total <sup>b</sup>								
Adults	29 872 600	13 023 500	31 586 700	13 880 600	32 448 000	16 224 000	33 253 200	14 614 100
Students	13 422 500	2 725 500	13 703 000	2 795 500	12 961 000	3 240 000	14 428 600	2 944 100
Total	43 295 100	15 749 000	45 289 700	16 676 100	45 409 000	19 464 000	47 681 800	17 558 200
Monthly-pass sales								
Adults	31 900	478 200	31 900	478 200	0	0	33 500	503 100
Students	16 200	121 200	16 200	121 200	0	0	17 000	127 500
Total	48 100	599 400	48 100	599 400	0	0	50 500	630 600

Note: Fare-patronage shrinkage factors based on four scenarios given in text: adults, 15 percent, 5 percent, 5 percent, and 5 percent, respectively; students, rural, 50 percent, 40 percent, 40 percent, and 40 percent, respectively; and students, other, 5 percent, 5 percent, 5 percent, and 5 percent, respectively.

<sup>a</sup> Existing fares. <sup>b</sup> Calculated at adults, \$0.50; students, \$0.25. Patronage shrinkage factors were applied.

HONOLULU CITY COUNCIL ACTIONS

On August 3, 1979, the Honolulu City Council adopted Ordinance 79-62, which established the new bus pass and fare program for TheBUS. Two additions were made to the proposed fare structure. First, a \$4.00/month school discount pass was included. Second, a \$1.00 family Sunday pass for unlimited rides on a given Sunday was included.

On November 1, 1979, the city and county began a monthly prepaid bus program and simultaneously increased the cash fare for passengers. The fare structure was changed to the following:

Type of Fare	Cost (\$)
Bus Passes	
Adult	15.00/month
Student	7.50/month
School discount	4.00/month (school days)
Family Sunday pass	1.00/Sunday
Senior citizen and handicapped	Free
Cash Fares	
Adult	0.50
Student	0.25
Transfers	Free

The bus pass program was modified, effective July 1980. The school discount pass and family Sunday pass were discontinued. A fare increase for the curb-to-curb Handi-Van service was enacted in April 1980, and the fare was raised from \$0.50/ride to \$1.00/ride.

BUS PASS SALES PROGRAM

Honolulu uses an outlet system to sell bus passes to the public. Selected companies who sell the passes enter into contract with the city specifying the methods for distribution and cash accounting. A total of 66 pass outlets include the state's largest bank (30 offices), a supermarket chain (17 stores), university campus center (1 outlet), Honolulu satellite city halls (9 districts), city bus information

center (1 outlet), and, since August 1980, a savings and loan company (8 offices). A distinguishing feature of Honolulu's program is that there is no commission for the sales. Sales by noncity outlets are made as a public service and as an opportunity to use the cash received as a "float" for almost a month. The pass sales procedure involves the following steps:

1. Printed passes are prepared by a private printer under contract with the city and county of Honolulu.
2. Passes for a given month are distributed to the main office of the various outlets. This is done on the first of the prior month. The passes are then distributed by the main office to the respective outlets.
3. Pass sales begin on the 16th of the previous month. Sales continue until the 15th of the month in question.
4. Funds are held by the commercial outlets in special accounts. These funds are transferred to the bus company, MTL, Inc., which consolidates the accounts for the city and county. The funds are transferred on the first business day after the 15th of the month, thus allowing the vendors a "float" for nearly one month. To maximize the cash advance, all sales are cash only and sales adjustments are made only at the main bus office. No refunds are made for lost or stolen passes.

There is a minimal amount of advertising for the bus pass program at this time. Television advertisements are provided free by the supermarket chain as a public service.

Two major advantages accrue to the city and the county in this procedure. First, the interest revenue lost by letting the outlets hold the pass sales receipts is less than the typical 3 to 5 percent sales commissions used elsewhere (4,5). The sales procedure also minimizes city accounting efforts since accounting is necessary only once a month.

## RESULTS

Total revenues for TheBUS system increased from \$10 million in FY 1979 to \$14.75 million in FY 1980. This increase is based on the result of the fare increase and prepaid pass sales for an eight-month period in FY 1980. Estimated revenues for FY 1980 were \$17 million given the fare increase and pass program for the entire fiscal year (3). By assuming the revenues for the first four months of FY 1980 identical to those in FY 1979 and by factoring the \$17 million figure for eight months, the revised figure of \$14.53 million was obtained. This compares favorably with the actual revenue of \$14.75 million.

Table 2 indicates the monthly pass sales trend from November 1979 through June 1980. Pass sales have generally increased with the exception of December 1979. During December, Hawaii experienced a statewide public worker's strike lasting nearly six weeks. Honolulu was also faced with the prospect of a sympathy strike by the Bus Operator's Union, which was negotiating a new contract at the time. However, there was an increase of \$50 000 in cash receipts for December over November 1979. In comparison, December 1978 cash revenues were \$10 000 less than November 1978 revenues (see Table 3).

Table 4 summarizes monthly patronage for FY 1979 and FY 1980. No patronage reduction was noted in November or December 1979 except for a traditional holiday season dip in patronage. In January 1980, the system recorded the highest monthly patronage since the city initiated the service in 1971. Historically, the month of February records a lower patronage than in January. However, in February 1980, there was an increase of patronage over that in January 1980. It is apparent that ridership did not decrease due to the increase in cash fares and the introduction of the bus pass program.

Initial pass sales of 34 000 were about 70 percent of the projected low estimate of 48 100 monthly passes (3). After six months, pass sales of 40 652 were nearly 85 percent of the projected low estimate. It is interesting to note that the student and school discount pass sales are quite close to the low estimate--15 190 to 16 200, respectively. Adult pass sales are lower than projected--25 800 to the projected number of 31 900.

Table 4 summarizes monthly fare revenues for FY 1979 and FY 1980. During this time period, service has remained nearly constant. Changes in revenue are thus a function of the change in fare structure and increased patronage growth on a stable system. Bus pass revenues approximate \$450 000 monthly as compared with the low estimate of \$599 400 (3). About 23 percent of the \$149 400 difference is due to the \$4.00 school discount pass, which was discontinued, effective July 1980. Cash revenues from the fare box have increased \$130 000 to \$170 000 per month as compared with FY 1979 monthly revenues.

In justifying the implementation of the prepaid bus pass program, a number of advantages were cited. The following discussion reflects Honolulu's experience with respect to the list of advantages.

1. The pass is convenient and easy to use. The success of the pass program indicates its overall acceptance by the community. Sales of the passes are good. The distribution system appears to be effective with pass sales at the bank outlets (\$200 000 monthly) and supermarket chain (\$220 000 monthly). These facts are indicative of the dispersed distribution of sales on Oahu.

Returns and exchanges of the prepaid passes have been minimal after the first two months of operation. There was some confusion on the use of the

student pass and the school discount pass in November. Also, the strike situation in December 1979 resulted in some requests for reimbursements.

There has been some abuse of the pass program, in particular the \$4.00 school discount pass and the \$1.00 Sunday family pass. Bus drivers reported youths were using the school discount pass on weekends, particularly at heavily used boarding areas. Sunday family passes were never successful with low sales after its initial start-up in January 1980. There were instances of large "families" boarding city buses by using a single \$1.00 pass. Both of these passes were dropped from use, effective July 1980.

2. Riders never have to bother with having correct change. The prepaid pass program is useful to riders who now can use their pass for unlimited rides in a given month. The cash-paying riders, however, are now confronted with a minimum two-coin fare (\$0.50), compared with the original one-coin fare (\$0.25). At the beginning of the pass and fare increase program, fareboxes on buses serving Waikiki were being jammed with paper bills due to the lack of change. This problem has since diminished.

3. The pass can be a bargain to regular users. While current statistics are not conclusive, the high pass sales indicate that purchasers are using passes for savings as well as for convenience. The City Department of Transportation Services will be undertaking ridership surveys in FY 1981 to verify pass usage in more detail. These surveys will be part of an ongoing bus system planning program for Honolulu funded by the Urban Mass Transportation Administration.

4. Bus passes simplify passenger loadings and increase bus speeds (by reducing loading times). Preliminary observations in Honolulu indicate that the pass program has simplified passenger loadings and faster load times are occurring. A before-and-after dwell time survey analysis is currently under way to develop regression equations for predicting loading times with and without a pass program.

5. Daily cash accounting would be reduced. The accounting system for fare and pass revenues was revised at about the time of the bus pass program implementation. There is no evidence that the accounting has been improved as a result of the pass program.

6. Cash flow would improve by advanced monthly payments. Under the Honolulu pass program, vendors hold the cash receipts until the middle of the current pass month. As such, the city experiences no gain from advanced monthly payments. The absence of pass sales commissions, however, results in a saving of nearly \$150 000 annually. The increase in cash fares has resulted in an improved daily cash flow.

## CONCLUSIONS AND RECOMMENDATIONS

The Honolulu program was successful in raising the additional revenue needed to offset increased operating and maintenance costs without a reduction in ridership. The success of the program rested heavily upon the community acceptance of TheBUS and the willingness of private companies to undertake the pass sales at no cost to the city. The approach used to project pass sales and system revenues is a feasible one and may be of use in the transit industry.

Honolulu's experiences with its prepaid pass program and fare increase can serve as a guide to other cities and transit properties who are planning to implement a transit pass program.

The following recommendations are intended to serve as guidelines and to identify appropriate areas for future research:

Table 2. Number of prepaid passes sold.

Month	Adult	Student	School Discount	Family	Total
1979					
November	22 287	4398	7 267	0	33 952
December	20 797	4496	6 226	0	31 519
1980					
January	22 028	4642	7 693	149	34 512
February	25 296	5046	9 046	136	39 524
March	25 743	5299	9 254	40	40 336
April	25 805	5224	9 547	76	40 652
May	24 923	5105	10 086	79	40 193
June	25 079	4343	2 858	0	32 280

1. Transit prepaid pass programs are viable programs for the transit industry. These pass programs should be introduced when there are general fare increases. The passes should offer a financial incentive for riders to use the pass. In Honolulu's case, 30 rides are the break-even level for a pass.

2. The transit pass program should be kept as simple as possible. The fare structure should be simple with a minimal number of pass types. Care should be taken to minimize the enforcement problems encountered by bus operators.

3. Community acceptance and involvement are extremely useful in advancing a transit pass program. The use of surveys to inform the public of problem

Table 3. System patronage: FY 1979 and 1980.

Month	Cash			Passes <sup>a</sup>					Grand Total
	Adult	Student	Total	Adult	Student	School Discount	Free	Total	
1978									
July	2780	1261	4041				632	632	4673
August	2773	1254	4027				618	618	4645
September	2662	1289	3951				609	609	4560
October	2769	1318	4087				634	634	4721
November	2688	1275	3963				617	617	4580
December	2658	1257	3915				600	600	4515
1979									
January	2903	1346	4249				651	651	4900
February	2767	1281	4048				624	624	4672
March	3063	1447	4510				693	693	5203
April	2814	1349	4163				644	644	4807
May	2739	1350	4089				632	632	4721
June	2669	1279	3948				610	610	4558
July	2874	1340	4214				656	656	4870
August	2890	1349	4239				650	650	4889
September	2729	1323	4052				630	630	4682
October	2877	1397	4274				656	656	4930
November	1514	712	2226	1244	253	366	709	2572	4798
December	1598	752	2350	1199	268	324	717	2508	4858
1980									
January	1704	802	2506	1270	276	401	773	2720	5226
February	1642	773	2415	1364	281	441	780	2866	5281
March	1660	781	2441	1484	315	482	818	3099	5540
April	1573	741	2314	1440	301	481	786	3008	5322
May	1549	729	2278	1437	304	525	788	3054	5332
June	1561	735	2296	1399	250	144	709	2502	4798

<sup>a</sup>Family Sunday pass usage was less than 1700/month.

Table 4. Revenue trends: FY 1979 and 1980.

Month	Cash			Passes <sup>a</sup>				Grand Total
	Adult	Student	Total	Adult	Student	School Discount	Total	
1978								
July	695	126	821					821
August	693	125	818					818
September	665	128	793					793
October	692	132	824					824
November	672	127	799					799
December	664	126	790					790
1979								
January	726	135	861					861
February	692	128	820					820
March	766	145	911					911
April	704	136	840					840
May	685	135	820					820
June	667	128	795					795
July	718	134	852					852
August	721	135	856					856
September	682	132	814					814
October	719	140	859					859
November	757	178	935	334	33	29	396	1331
December	799	188	987	312	34	25	371	1358
1980								
January	852	201	1053	330	35	31	396	1449
February	821	193	1014	379	38	36	453	1467
March	830	195	1025	386	40	37	463	1488
April	787	185	972	387	39	38	464	1436
May	775	182	957	374	38	40	452	1409
June	780	184	964	376	33	11	420	1384

<sup>a</sup>Less than 150 family Sunday passes were sold in any one month.

areas as well as to collect data regarding those areas is helpful.

4. There is a need to update and expand the Simpson-Curtin formula to account for inflationary effects on transit fare increases. There is also a need to include variables that account for travel cost changes in competing modes of travel.

5. There is a need to examine transit pass usage patterns. Delineating "convenience" users from "financial savings" users and obtaining information on their usage frequency would be helpful for marketing analyses and predicting revenue trends.

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#### Abriđgment

## Measured Fare Elasticity: The 1975 BART Fare Change

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By using the measured response of San Francisco Bay Area Rapid Transit (BART) patrons to a fare structure change in 1975, this paper shows that variance in empirical demand elasticities can be strongly and inversely related to the level of patronage aggregation considered and the relative change in fare. The 1975 fare structure change affords a unique opportunity to observe such variance with both increases and decreases in fare occurring for cases at different fare and patronage levels. Two levels of aggregation are considered. One is the systemwide total response aggregate; the other treats each origin-destination data element as a separate case. Different values are computed for elasticity and are found to be related to the level of aggregation. Elasticity functions are also derived from the cases for use in BART forecasting procedures. Analysis for the correct weighting factors to use in fitting the elasticity functions indicates that variance of the measured elasticities is related to the case patronage levels and the square of the difference in logarithms of the fares before and after the change. The fitted elasticity functions also demonstrate that divergences in values of elasticity can be a function of both model specification and the operating point selected for the calculation of elasticity from the function.

The objective of this study was to more accurately represent the varying response of San Francisco Bay Area Rapid Transit (BART) patrons from different market areas to fare changes through derived elasticity functions. Elasticity functions aid in the prediction of responses to fare structure changes at a more refined level of critical system screenlines. They also provide potential controls for studying level-of-service impacts during simultaneous fare and level-of-service changes on BART in mid-1980.

This paper presents results for both calculated constant aggregate elasticities and acceptably fitted elasticity functions that quantitatively demonstrate how much divergence can occur with such computations. An important reason for this divergence is the high variance in the response of trip making to a fare change that appears to be inversely related to the level of patronage. Variance may provide an additional explanation for controversial inconsistencies in elasticity estimates (1,2).

#### FACTORS IN DIVERGENT ESTIMATES

Depending on the level of aggregation used in computation, the data in this study yielded different

values for average elasticity. This was not unexpected since Chan and Ou (1) had hypothesized that aggregate empirical elasticities based on coarse demand data would tend to underestimate the response while disaggregate calibrated elasticities, mostly based on zonal and household data, would overestimate. Thus the absolute value of the aggregate elasticity would be less than that of the disaggregate elasticity. The calculated aggregate elasticity did demonstrate this relation with respect to the average elasticity for the set of origin-to-destination cases that is a more disaggregated level of data. In this case, such differences appear to be an artifact of the method of computation and the aggregation of data.

Gomez-Ibanez and Fauth (2) offer three other explanations for such differences: variations in data accuracy, failure to capture characteristics differentiating markets, and different variables included in model specifications. Model specification does appear to be a significant factor for elasticity functions derived from mathematical models of demand. Ruiter (3) provides an excellent summary of many travel demand models along with derived elasticity functions. In most of the forms summarized, elasticity is not a constant. It is, instead, a function of the variables in the model, most often of the cost variable. Different sensitivities are thus implied for the value of elasticity. A departure from base values for the variables in the function results in a divergence in values computed for elasticity. If results in this paper can be extrapolated, differences on the order of 30 to several hundred percent can easily occur.

Measured elasticities attempt to describe the response of demand to a change in cost directly. An increase in trip cost can be expected to reduce trip making. Adjustments can be made for seasonality, trip purpose, accessibility to alternative stations, and perceived value of cost and its change with time. But adjustments cannot be made for all factors. Thus, erratic values for elasticity can be expected. The extent of the erratic behavior can be surprising. For example, elasticity for daily demand in the 793 selected cases ranged in value from