Chapter 1

AN ANALYSIS OF BART'S LEVEL OF SERVICE

Deborah M. Kramer

Introduction

As the population of the Bay Area grows, so does the congestion of its roads and highways. A poll taken in 1985 by the Bay Area Council (1986) indicated that Bay Area residents consider transportation their greatest concern. The major forms of mass transit alternatives are buses, MUNI Metro, and the Bay Area Rapid Transit District (BART). BART currently carries a healthy share, approximately 16 percent, of the average daily commute of the three major means of mass transit (Metropolitan Transportation Commission [MTC], 1986).

BART is a heavy rail system composed of 71.5 miles of track spanning Contra Costa, Alameda and San Francisco counties, and includes the Transbay Tube. The Tube connects Oakland and San Francisco and is the world's "longest and deepest vehicular tube" (BART, 1984). Since its opening of service on September 16, 1974, over 200 million people have travelled through the Tube (BART Department of Planning, Budgeting and Research [PBR], 1972-1986); roughly one-third of the peak-hour transbay traffic is served by BART (BART, 1984).

The development of the BART system has had an important impact on the lives of many residents. People choose BART to commute between their homes, work, and school and for a variety of leisure-time travel. Many people use BART, for example, to go to concerts and sports events at the Oakland Coliseum, to the Bay-to-Breakers race in San Francisco, and for holiday shopping at Union Square.

This paper analyzes BART's past, present and future levels of service to the Bay Area. The analysis presents historical trends in ridership and assesses how BART may contribute more effectively to the movement of commuters. BART can be an even more effective service for Bay Area residents than it already is.

Past Studies

Parsons-Brinckerhoff-Tudor-Bechtel, and others (PBTB, 1962), was the initial proposal for the three county region to be serviced by the rapid transit system. Wilbur Smith & Associates (1971) published a report prior to the commencement of BART's revenue service discussing BART's capabilities and the feasibility of another bridge.

The U.S. Departments of Transportation and of Housing and Urban Development sponsored a report which is a collection of studies indicating the impacts BART has had on the people who use BART, construction activities and developments around BART stations, and the effects on various local transit services. Sherret (1979) gives a general overview of the travel and transportation impacts

BART had on Bay Area residents during its first five years of operation, 1972-1977. Markowitz (1984) published an update to the MTC report summarizing his observations of the effects of the BART/MUNI fast pass and impacts of gasoline prices and availability on BART's ridership.

Methodology

An historical section discusses prior modes of transportation and the proposals which demonstrated the need for rapid transit in the Bay Area. Ridership trends on BART are then presented and analyzed.

Three categories of factors affecting the level of service on BART are apparent. The first category is "technical" factors, which involve problems with and improvements to system hardware and operations; technical factors analyzed here include the A-, B- and C-cars, the computer system, automatic train controls, and the Daly City turnback and yard. The second category is "internal" factors. Management decisions and labor disputes comprise this category. The last group of factors are "external" to BART; BART's management has no control over many events which lead to patronage fluctuations. These events include strikes by employees of AC Transit and MUNI, fluctuations in gas prices and availability, cost and availability of parking (mainly in Oakland and San Francisco), and corporate migration to the suburbs.

Based on an analysis of the historical trends in ridership and of the factors indicated, I speculate about the future of BART's level of service. A final section presents conclusions regarding the potential for improvement.

Historical Developments Leading to BART

Ferries were the first form of mass transit in the Bay Area; for well over a century they carried thousands of commuters between San Francisco, Marin and Oakland. Later, trains and trolleys, and eventually buses, were added to the transportation system. The Key System, formed in 1903 to provide additional transit service, expanded to include electric trains crossing the lower deck of the Bay Bridge, which was completed in 1937. A record 34.9 million passengers used the Key System in 1945 (Demoro, 1986b).

In 1947, an Army-Navy commission recommended "that an underwater tube be built in order to relieve the automobile congestion" across the Bay Bridge (BART, 1984). The growing use and ownership of cars due to a heavy post-war migration of people to the Bay Area caused the collapse of the Key System in 1958. People gathered informally to discuss alternatives for reducing the increased traffic congestion on the San Francisco Bay's bridges and highways (BART, 1972). The primary rationales presented to the public on the decision to build BART centered around two interrelated themes: the vitality of major cities would be endangered by the ever-increasing traffic congestion along the major highways; and, a "high-tech" heavy rail transit system would provide the additional transit capacity necessary for continued growth in the outlying urban areas while avoiding the difficulties associated with expansion of the freeway system (MTC, 1979).

In 1957, the California Legislature approved the creation of the Bay Area Rapid Transit District, consisting of Alameda, Contra Costa, Marin, San Mateo and San Francisco counties. San Mateo County withdrew from the District because of high property taxes and because the Southern Pacific commuter rail system was already in use (BART, 1972). Shortly thereafter Marin County's engineering review panel concluded that the Golden Gate Bridge was incapable of carrying rapid transit vehicles, and Marin withdrew from the District (PBTB, 1962).

In 1962, an initial design proposal, consisting of reports by engineering and economic consultants, was presented to the District's Board of Directors (PBTB, 1962). This proposal called for a 71-mile heavy rail system to provide service to the major business and commerce centers in the three remaining counties. The engineering consultants recommended that the system include average speeds, including station stops, of 50 miles per hour; 90 second "headways" (the time separating the front of two trains travelling in the same direction on the same track); and automatic train controls (ATCs) on each lead car for reliability. A computer would monitor all the trains, their locations, station stopping time, and abnormal conditions. An attendant on board the train would override the ATC when necessary to reduce train speed or to stop the train. The report estimated the cost of the system at over $996 million, with an expected service start-up date in 1969.

Not until 1969, however, did the District's voters approve a $792 million bond issue to allow construction; this vote was followed by the State Legislature's approval of a one-half cent sales tax in the BART counties to raise an additional $150 million to complete BART (Kleffman, 1986). BART's first line of revenue service opened on September 11, 1972, between Fremont and MacArthur stations in Alameda County. The Transbay Tube opened September 16, 1974.

Ridership Trends

People ride BART for one or more of a variety of reasons--comfort, safety, security from crime, release from driving, out-of-pocket cost advantages over automobiles, and BART's energy efficiency (Sherrett, 1979; BART Public Information Office [PIO], 1985; MTC, 1979). Throughout its history, however, BART patronage has been quite sensitive to internal and external events. The patronage fluctuations are presented in Figure 1.

The graph indicates a growing trend until mid-1985. The addition of the Transbay Tube to the system in September 1974 led to average daily patronage crossing the 100,000 mark. Each fare increase (D, K, M and O on Figure 1) is accompanied by a slight initial decline in patronage. Sharp peaks resulted from MUNI and AC Transit strikes in 1976 and 1978. Sharp dips in ridership were caused by BART's closure due to the Transbay Tube fire in January 1979, and a BART strike in late 1979. The recent sudden decrease in ridership from 215,000 to 185,000 patrons is mainly due to dropping gasoline prices coupled with BART's fourth fare increase. The events surrounding these fluctuations are discussed in more detail in the following factors analysis.

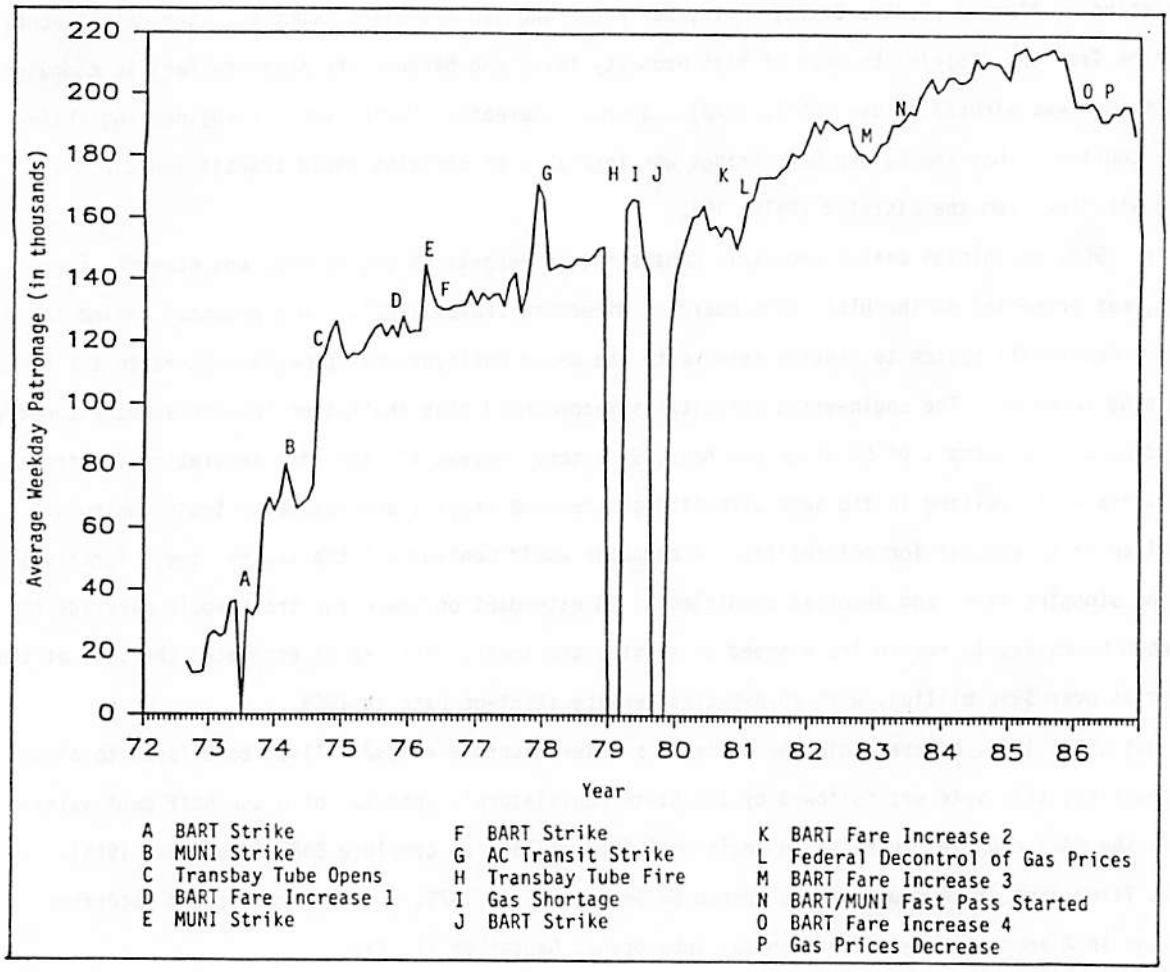

Figure 1: Average number of weekday passengers on BART, 1972-1986.
Source: BART PBR, 1972-1986.

Technical Factors

The BART system consists of 71.5 miles of rail, 34 stations, about 450 cars, wayside train controls and a central computer. During rush hours in the commute direction, BART's use of energy is "ten times as efficient" as that of the other forms of mass transit (BART PIO, 1985), but the system as a whole has not been as reliable as it was hoped it would be. The numerous system breakdowns in the early years of BART's operations "were traced to an untried high-tech approach to transit" (Sweeney, 1986).

The main problem of the early system was in the old ATC equipment in the A-cars (lead cars). ATCs are radio-wave-controlled receivers that interpret signals from the Central Train Computer, which can supervise up to 49 trains. BART recognized the failure of the ATC equipment as the "largest cause

of service disruptions" (BART PIO, 1986). Breakdowns of the old ATCs resulted in delayed trains, which caused the wayside train controls (devices on the tracks which control train spacing and tell the train how fast to go) to alter the headways, further increasing the disruptions to service.

This problem will be completely resolved when the new Integrated Control System (ICS) becomes operational. The ICS is an upgraded Central Train Computer which will permit up to 75 trains to be operated on the system at one time. The ATCs in the A-cars are also being upgraded. The improved ATC units will be linked to the ICS; the new system will be completed in October 1987. In January 1989, 150 C-cars (newly designed cars which can operate as independent units or as either lead or mid-train cars) will be added to the existing fleet of 440 A- and B-cars, and will contain the new ATC systems.

Crowded trains are a strong deterrent to riding BART during peak hours of 7:00 a.m. to 9:00 a.m. and 4:30 p.m. to 6:30 p.m. Load factors (the number of people on the train divided by the number of seats) at these times are currently higher than the level BART management considers optimal. To achieve lower load factors, BART plans to couple activation of the ICS with completion of the new Daly City Turnback in early 1988. The Daly City Turnback is designed to turn trains around at the end of the line in Daly City. It will be an off-line facility which will allow trains to run at closer headways. Currently, the turn-back rate of trains is 3.75 minutes; with the new turn-back facility, the rate will be reduced to 2.25 minutes. Implementation of this increased turn-back capacity will be aided by the ICS and by the addition of the C-cars to the fleet. This system upgrade will result in an 85 percent increase of BART passenger capacity (BART PIO, 1986).

Internal Factors

The major internal factors affecting BART's level of service are labor and management decisions. The BART strikes in 1973, 1977 and 1979 put small dampers on ridership (Figure 1), but the patrons came back to ride BART. Within a few months, ridership figures were back to their original levels.

Fare increases have had similar effects upon ridership (Figure 1). The first fare increase, of roughly 21 percent, was in 1975; ridership plummeted. Over the next five months, patronage slowly climbed back to the original level. Five years later, BART increased its fares again, by an average of 36 percent; the rebound of patronage took about eight months. The same was true for the 18.4 percent increase in August 1982 (BART, 1986a).

In January 1986 BART again increased fares, by an average of 30 percent, anticipating the same eight-month recovery. But shortly after the fare increase, gas prices dipped sharply; BART ridership remained depressed. BART's timing of its fare-hike was not good. The already-jammed parking lots at BART stations and late and overcrowded trains probably contributed to discouraging ridership (Demoro, 1986a). The average weekday patronage prior to the fare increase was as high as 215,000; after the fare-hike, ridership dropped to a low of 187,000 in December 1986 and averaged 195,000 trips per weekday during calendar 1986.

BART's patronage levels have been bolstered by the cooperation of BART and MUNI in the creation of Fast Passes in 1983. These monthly passes enable users of MUNI and of San Francisco BART stations to have better transit access on both systems. An initial increase of 5,000 riders was observed, mostly due to the multi-transit pass. The overall increase in BART ridership from 1983 is due in large part to the use of the BART/MUNI Fast Pass by formerly MUNI-only riders on the BART system (BART PBR, 1972-1986).

In January 1987, BART and AC Transit joined forces to present the public with an AC/BART Pass, entitling the bearer to ride both AC Transit and BART with the purchase of a two-week pass. Figures were unavailable for an analysis of the effect of the passes on ridership.

External Factors

Markowitz (1984) noted that "BART patronage has been sensitive to external events." Labor disputes involving other transit systems and a variety of factors external to BART comprise the final category of factors influencing average daily ridership.

As seen in Figure 1, strikes by AC Transit and by MUNI coincided with significant fluxes in the number of people riding BART. There was a small addition of riders during the 1974 MUNI strike, but MUNI's 1976 strike resulted in nearly 22,000 additional weekday riders on BART while it lasted. After the strike ended, BART continued to serve more people than it had before the strike.

An even larger effect was observed during the AC Transit strike during two months in 1977-78. When the buses stopped running, up to 35,000 people chose to ride BART during the weekdays. This significant increase had a lasting effect; after the strike was over, patronage levels had increased by roughly 10,000 passengers from pre-strike levels.

Throughout 1978 ridership continued to increase, and it soared during the gas shortage in 1979. Gasoline prices and availability are reflected in BART's patronage levels (Figure 1). The decontrol of gasoline prices in 1981 led to skyrocketing fuel costs and an equally impressive increase in BART ridership. The reverse occurs when gas prices plummet, as is apparent in 1986. BART's Department of Planning claims that the recent gasoline price decrease led to less than a one percent drop in patronage (Reinke, 1987); my observations and communications with past and present riders, however, indicate that the decrease in fuel prices may have been a large contributor to the patronage decrease.

Although gas prices have recently decreased significantly, BART is still an economical mode of transportation, a fact which many people do not recognize. Out-of-pocket round-trip costs between the East Bay and downtown San Francisco via BART and private autos are presented in Table 1. The average parking charge is $5.50 per day, but prices reach $15.00 per day in some downtown garages, where parking is very scarce and property values are high. An average trip of 20 miles between the East Bay and San Francisco costs around $11.36 by auto, while the costs on BART are only $4.20, for a savings of over $7.00.

Distance in Miles	Out-of-Pocket Round Trip Cost Between East Bay and Downtown San Francisco *	
	BART	Auto
10	$3.50	$ 8.80
20	4.20	11.36
30	5.60	13.91

*1. BART costs are fares from stations at approximately the indicated distance

*2. Auto out-of-pocket costs based on 12.8 cents/mile in Spring 1986; two-way toll of 75 cents; and average parking charge of $5.50/day. Cost estimates based on research by Metropolitan Transportation Commission adjusted for inflation

Table 1: Comparison of trip costs by BART and by auto.
Source: BART 1986b.

Many companies have moved their business offices to the surburbs because of the high rents and parking costs in San Francisco. As a result, travel patterns in the Bay Area are beginning to change (Seto, 1986). Large corporations such as Bank of America, Chevron USA and Pacific Bell have moved their headquarters or back office operations to the East Bay, especially to Contra Costa County. BART and other transportation districts have felt a slight decline in patronage, partly due to corporate migration.

The recent population growth in Alameda and Contra Costa counties increased the feasibility of corporation migration. The existence of BART was a factor in East Bay growth; office construction permits increased and housing projects opened in the vicinities of BART stations as they were added to the system (MTC, 1979).

The Future of BART

The Association of Bay Area Governments (1985) predicted that over the next 20 years the "San Francisco Bay Area will add one million new residents," generating 1.1 million new jobs. Cities in the three counties in the BART District are anticipated to undergo the greatest percent population change in the Bay Area (Amador-Livermore Valley), the highest employment growth rate of the nine Bay Area counties (Concord, Pleasant Hill, San Ramon and Walnut Creek), and major employment shifts (San Francisco City and County). Mass transit in general, and BART in particular, clearly will have an important role to play in coping with these demographic changes.

At the present time gasoline is cheap and plentiful, while BART fares are higher than many people are willing to pay. Companies have moved to the suburbs and continue to do so, leading to a major change in travel patterns. What can people look forward to from BART? Will it be able to maintain or expand its role in the regional transit system?

Currently, the BART District has worked out plans for acquisition of land for extensions of the system (MTC, 1984). The first planned extension is to run the Concord line out to West Pittsburg. However, Measure C, which sought to raise $185 million for this extension by increasing sales taxes another one-half cent in Contra Costa County, was defeated on the November 1986 ballot by the county's voters (Kleffman, 1986).

BART management is reconsidering its 1986 fare increase and contemplating reducing fares to lure riders back to BART (Demoro, 1987). BART considered a two-tiered fare structure prior to the last fare-hike, in which peak period fares would be higher. This proposal has been rejected as too complicated and unlikely to increase the net profit (Stamas, 1986, pers. comm.). The 30-percent fare increase in 1986 has given BART the extra revenues it was looking for (about a 20 percent gain), but the cost has been a decrease in patronage of approximately eight percent (Stamas, 1986, 1987, pers. comm.).

Buses are a key link to helping BART work. Barbara Neustadter, a BART planner, noted that "what is required to get people on a bus is a lifestyle change. People aren't in that much pain yet to make that change [to feeder buses]" (quoted in Demoro, 1986a). An example of a working feeder bus link to BART is the County Connection line which runs to Bishop Ranch business park from the Lafayette BART Station. Cooperation between the bus companies and BART to create more feeder bus services could substantially enhance BART patronage.

Technical improvements to the system, such as the addition of C-cars and the Daly City Turnback, will greatly enhance BART's appeal to patrons. More trains and shorter headways will lead to a decrease in load factors, which is the main intention of these improvements.

Conclusion

BART management seems to be headed in the right direction with its technical improvements to the existing system. The internal factors affecting BART's level of service are acknowledged by the District. Gasoline prices and labor disputes from other systems will always affect BART's patronage. Perhaps BART could prepare for these external events in the future by keeping load factors at optimal levels, so that a surge in patronage from transit strikes or gas price hikes would not force people to endure such crowded situations as they have in the past, and a greater number of BART's new riders would become converts to the system. Fare cuts when fuel prices drop could also aid in continuing higher patronage levels.

Unfortunately, BART needs to maximize its revenue from the farebox. As expenses increase, fares must also increase to ensure a reasonable "farebox ratio" of over 50 percent. But sometimes it seems

that BART management loses sight of its public service mission, and sees only the lure of money. Its public image lately has been poor. Fare cuts and improved reliability could be a significant step towards improving BART's appeal. Necessarily, as traffic congestion worsens and energy prices rise, people will increasingly turn towards mass transit; BART could be in a good position to attract the bulk of these riders.

I would like to see BART's management embark on a campaign to convince commuters to choose BART as their main source of transportation, because there is a tremendous need for people to begin utilizing public transit. Otherwise, the current "greatest concern" of Bay Area residents will become even greater in the future.

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