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THE EFFECTS OF LABOR STRIKES ON BUS TRANSIT USE

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PURDUE UNIVERSITY

Final Report

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ABSTRACT

The effect of strike-induced transit shutdowns on the short and long-run demand for mass transportation services is of increasing importance to transportation planners and transit operators. Set against a backdrop of declining ridership trends, increasing labor union activity, and the growing costs involved in operating a transit system, such strikes become a major concern in the effort to reverse the long-term deterioration of public transportation services in this country.

This study concerned itself with several problem areas. First, a review was made of the present day labor-management relationship, and the collective bargaining process in the urban transit industry. Several case studies of urban transit strikes were then examined.

The major research effort involved analyzing a questionnaire sent to selected transit companies across the United States. Survey intent was to investigate the impact of a work stoppage on six variables: average adult fare, total route length, total vehicle-hours of operation, average daily ridership, and two derived indices. Change in ridership as a function of the other five variables, effect of strike duration, and the influence of service area population size and management type was examined using analysis of variance and regression.

Major findings of this survey included:

a) Strike probability increases with increased system size, regardless of system management type.

b) Industry-wide strike incidence has increased in recent years.

c) Average adult fare increases immediately after a strike, with a greater increase over the long-term.

d) Transit service (vehicle-hours of operation, miles of route, service indices) does not change immediately after a strike, or over the long-term.

e) Average daily ridership decreases immediately after a strike, with a smaller but still significant strike-induced decrease over the long-term.

f) Smaller systems experience a faster patronage recovery than larger ones. Also it appears that pre-strike captive riders return to the system much faster than pre-strike choice riders, who may not return at all.

g) Immediate post-strike patronage decline is difficult to predict. Long-term patronage decline can be predicted with a high degree of confidence, and is greatly dependent on service area population size and services changes.

h) System susceptibility to more than one strike in the last fifteen years does not vary with system size or management type.

Better marketing practices contribute to the continuing effort for transit revitalization. However, a strike frustrates management efforts to broaden its market by driving away "choice" and marginally captive patrons, who appear to return to the affected system much slower than pre-strike "hard" captives. Additionally a post-strike service decrease hurts the long-term recovery of former and potential users.

CHAPTER 1: INTRODUCTION

The effect of strike-induced transit shutdowns on the short and long-run demand for mass transportation services is of increasing importance to transportation planners and transit operators. Set against a backdrop of declining ridership trends, increasing labor activity, and the growing costs involved in operating a transit system, it becomes a major concern in the effort to reverse the long-term deterioration of public transportation services in this country. Strikes can only serve to aggravate an already delicate relationship between the transit property and consumers of its services.

In the past many transit administrators have believed that ridership falls significantly and permanently after the occurrence of a strike. Such an assumption contradicts the commonly held opinion that most transit users today are "captive" to the transit system. There are many factors which might influence the decision of patrons to leave the system; a loss in service, an increase in fare, the size and land use pattern of the city in which they live. In this study an attempt will be made to shed some light on the problem of post-strike passenger diversion.

First, a review is made of the present day labor-management relationship and the collective bargaining process in the urban transit industry. In order to give the reader a better understanding of the complex interactive effects which occur during and after a strike, several case studies of urban transit strikes are then examined. The major portion of this study involves an

analysis of a survey which was sent to selected transit properties across the United States. The survey analysis, combined with the information found in the literature, are used to give a more intensive nationwide review of service interruption consequences on urban mass transportation.

CHAPTER 2: BACKGROUND

Unionization in the Transit Industry[1]

The transit industry is a highly labor intensive field, thus the cost of manpower typically represents from 60% to 80% of all operating costs to a property.[2] In most cases only one company operates in each Standard Metropolitan Statistical Area (SMSA). Where there is more than one organization, they seldom have competing routes. Thus most transit properties could be classified as monopolists, with each limited to one locality. It must be recognized, however, that there is other competition for the transportation needs of the consumer, most notably the private automobile.

The industry is almost completely unionized, approximately 95% of those surveyed by the American Transit Assoc. have collective bargaining contracts.[3] Thus a major portion of the total expenses of any transit system will be payments to workers represented by unions. This reinforces the importance of good labor relations in the stable operation of transportation services.

In both public and private properties there is generally one union and one bargaining unit, usually consisting of all organized workers in a given transit company. This typically includes operators, maintenance workers, and clerical employees. Because of joint bargaining, the number of bargaining units is smaller than the number of unions in all cases.

The majority of workers belongs to either the Amalgamated Transit Union (ATU) or the Transport Workers

Union (TWU). A small proportion of workers are organized by various other craft or independent unions.

In terms of number of collective bargaining contracts, the ATU is the dominant union in the transit industry. It has frequently used voluntary binding arbitration for the resolution of impasses, and generally is less antagonistic toward management than the TWU. However, it was TWU's strong union actions which enabled it to be the only one to organize the New York properties, where it is now predominant.

Organizational structure in both unions reveals that the power to act in non-collective bargaining matters is concentrated at the top. However all decisions are subject to membership reversal, and all leaders undergo frequent re-election. In collective-bargaining matters the national leadership can play an important part, but all decisions are subject to approval by the affected membership. In both bargaining and administrative matters control is much more centralized in the TWU than the ATU.

Collective Bargaining - A Short Perspective[4]

Transit industry revenue and patronage trends are illustrated in Tables 2.1 and 2.2. As can be seen, the economic fortunes and the total passengers carried on public transportation have been on an almost continuous decline since 1945. Operating expenses (including taxes) have exceeded operating revenue for the past 13 years.

Due to declining patronage and revenues, and because the industry supplies such an important service, public ownership has increased. This, of course, has greatly expanded governmental involvement in the collective bargaining process.

Table 2.1. Trend of Transit Operations

Calendar Year	Operating Revenue (thousands)	Total Operating Expenses (thousands)	Net Operating Revenue (loss) (thousands)
1940	$ 737,000	$ 660,720	$ 76,280
1945	1,380,400	1,231,670	148,730
1950	1,452,100	1,385,730	66,370
1955	1,426,400	1,370,690	55,710
1960	1,407,200	1,376,510	30,690
1961	1,389,700	1,372,970	16,730
1962	1,403,500	1,383,800	19,700
1963	1,390,600	1,391,480	880
1964	1,408,100	1,420,490	(12,390)
1965	1,443,800	1,454,410	(10,610)
1966	1,478,500	1,515,570	(37,070)
1967	1,556,000	1,622,568	(66,568)
1968	1,562,739	1,723,811	(161,072)
1969	1,625,633	1,846,145	(220,512)
1970	1,707,418	1,995,630	(288,212)
1971	1,740,700	2,152,100	(411,400)
1972	1,728,500	2,241,626	(513,126)
1973	1,797,640	2,536,139	(738,499)
1974	1,939,700	3,239,373	(1,299,673)
1975	2,002,370	3,705,896	(1,703,526)

Adapted from: American Public Transit Association, Transit Fact Book: 1975-1976 Edition, 2nd ed. (Washington, D. C.: APTA Statistical Dept., 1976), p. 28.

Table 2.2. Trend of Total Transit Passengers

Calendar Year	Rail Transit (millions)	Bus Transit (millions)
1940	8,325	4,239
1945	12,124	9,886
1950	6,168	9,420
1955	3,077	7,250
1960	2,313	6,425
1961	2,289	5,993
1962	2,283	5,865
1963	2,165	5,822
1964	2,166	5,813
1965	2,134	5,814
1966	2,035	5,764
1967	2,201	5,323
1968	2,181	5,610
1969	2,229	5,375
1970	2,116	5,034
1971	2,000	4,699
1972	1,942	4,495
1973	1,921	4,642
1974	1,876	4,976
1975	1,804	5,068

Adapted from: American Public Transit Association, Transit Fact Book: 1975-1976 Edition, 2nd ed. (Washington, D. C.: APTA Statistical Dept., 1976), p. 32.

Prior to 1951 the great majority of labor-management disputes were resolved through the use of binding arbitration. In the early 1950's, however, an increase in the number of strikes against transit properties prompted several states to pass laws regulating the bargaining process. While the intent of these actions was to prevent work stoppages from occurring, it seemed to have the reverse effect. Due to constraints imposed upon it during bargaining, management became increasingly disenchanted with regulated forms of arbitration, and the strike became the sole method of resolving negotiation impasses.

In the late 1950's an increasing number of transit properties were reorganized as publicly owned systems. Thus, even though the means to settle disputes in the private sector remained similar to those used in other types of business activities (e.g. strike), a greater number of transit industry contracts were being settled in the public sector, using procedures for reaching a compromise without a strike. The most common techniques that have been utilized are binding arbitration and unilateral determination by management.

The passage of the Urban Mass Transportation Act of 1964 led to an even greater shift of transit properties from private to public ownership. Since the right to strike has become illegal for most public system employees, a large percentage of the firms in the industry have been forced to replace the strike with other means of impasse resolution. In the majority of cases this has involved some form of compulsory binding arbitration. A highly visible sign of this change in tactics has been an increase in the number of contract negotiations that have been settled by this form of arbitration.

However, even though in many instances the unions may have lost the legal means to strike, they are still powerful enough to force a favorable settlement in other ways. Common tactics have included the use of political power, the threat of an illegal strike, or at times by actually striking. Thus, even though the strike is gradually being replaced with other methods of resolving contract disputes, unions have still managed to retain their predominating influence at the bargaining table.

Factors Related to Transit Strike Impact

The quantification of transit strike impacts is an extremely complex problem. When designing the questionnaire study described in later chapters, only six variables were chosen for purposes of assessment. In reality there are more related variables. Inclusion of the numerous variables and interactions among demand and service measures would require an analysis that is beyond the scope of this study. However, in order to give one an appreciation of this problem, several of the more important factors are listed below:

1. impact on various socio-economic groups
2. impact of competing non-striking modes (e.g. schedule changes, extra transit vehicles placed in operation, route alterations)
3. improvements to the highway system
4. geographical considerations such as orientation of the CBD, number of access points to the CBD, orientation of the transportation system
5. characteristics of the transit property involved in the labor action (e.g. size of system relative to the entire transportation network, state of repair or disrepair of the rolling stock, percent of total daily trips captured by the company)

6. percent of population using public transportation
7. stage of degeneration or revitalization of the CBD
8. effect of an anticipated fare increase
9. interaction of the various modes reflected in such terms as availability of transfers and configuration of feeder systems
10. nature of the strike such as duration and comprehensiveness
11. other transportation services offered in the city
12. percent of working force employed in the CBD and their distance to work
13. public opinion of the strike
14. extent of political involvement

The amount people must pay to use a transportation service and its influence on transit patronage have been well documented in the literature. It is particularly applicable to a strike study as labor-favorable contract settlements could force transit management to increase fares in order to raise additional revenues. An analysis of pricing changes resulting from a service interruption was included in the questionnaire study, however at this time it seems appropriate to introduce two studies regarding this matter.

The first study was conducted by Simpson and Curtin in the early 1960's; they found that since 1947 price increases have had a fairly stable relationship with respect to patronage. It was found that revenue passenger totals decrease 1/3 of 1% for every 1% increase in the average fare. This value has remained highly consistent over the past two decades, with slight variations subject to changes in city population.[6]

The second study, conducted by Michael A. Kemp of the Urban Institute in the early 1970's, further suggests that although transit demand changes with respect to fare,

ridership is significantly more sensitive to changes in the level of service.[7]

Before initiating a more in-depth analysis of transit strike effects, based on questionnaire data obtained during the course of this study, it seems best to review some prior research on this subject which has been completed. The following overview of these several case studies, their findings and conclusions, should serve as an excellent guide when considering the many variables influencing post-strike patronage levels.

Notes

1. Material for this section was primarily drawn from: Darold T. Barnum, Collective Bargaining and Manpower in Urban Mass Transit Systems (Philadelphia: Transportation Studies Center, University of Pennsylvania, 1972).

2. W. Homburger, "Characteristics of Mass Transit Systems," in Urban Mass Transit Planning, ed. Wolfgang Homburger (Berkeley: University of California, 1972), p. 47.

3. American Transit Association, cited by Darold T. Barnum, Collective Bargaining and Manpower in Urban Mass Transit Systems, p. 65.

4. Material for this section was primarily drawn from: Darold T. Barnum, Collective Bargaining and Manpower in Urban Mass Transit Systems.

5. Simpson and Curtin, "Special Report - Fares," Metropolitan Transportation, LVIII (January, 1962) cited in Barnum, Collective Bargaining in Urban Transit, p. 30.

6. Darold T. Barnum, Collective Bargaining and Manpower in Urban Mass Transit Systems (Philadelphia: Transportation Studies Center, University of Pennsylvania, 1972), p. 30.

7. Michael A. Kemp, "Some Evidence of Transit Demand Elasticities," WP 708-52 (Washington, D.C.: The Urban Institute, 1971).

CHAPTER 3: CASE STUDIES

Until very recently only a minimal amount of literature has been available which was devoted to transit strike impacts. One of the early efforts was a study prepared by the consulting firm of Barrington and Company. This report evaluated the impact of a work stoppage by seven New York City transit properties from January 1 to January 13, 1966. Its purpose was "to establish the effect of the strike on the public and on its future travel patterns."[1] Through a series of approximately 10,400 telephone and home interviews the study team segmented the transit market into several user groups (workers, shoppers, other-purpose transit users, non-regular transit users) from which they determined the strike influence, including any post-strike diversion from the transit system.

This study concluded that:[2]

> After the strike, 2.1% of the regular transit-using workers in the four major boroughs stopped using the system. These workers were from younger, more affluent white-collar households. They had local destinations, that is, within their own residence zones, more so than those who went back to subways and buses. Also, more of them had driven in their own cars during the strike rather than in a pool.
>
> Shoppers who did not return to using the mass transit, however, reverted to walking in more than half the cases. They were younger than transit-using shoppers as a whole.
>
> Those who stopped using the mass transit system for social and personal activities shifted, in more than half the cases, to their own cars and taxis after the strike but one-third had no fixed modal pattern. These households were younger, but more were lower-income, than the other-purpose transit users who did return to the system.

After the strike, 5% of the suburban users, for any purpose, stopped using the city transit system.

A second well-known study effort was an analysis of the 1974 Southern California Rapid Transit District (SCRTD) Strike. Bigelow-Crain Associates conducted this study "to evaluate, in limited manner, the most obvious and immediate effects of the SCRTD labor strike on the mobility and commerce within the impacted area."[3] Survey methodology included interviews with selected agencies and businesses, a random ride survey, a shopping center survey, traffic data, a San Bernardino Busway survey, a carpooling program report, and state-wide data to act as a control.

Significant conclusions were:[4]

1) Impacts on retail sales resulted in losses of 10 to 30% in transit-related areas.
2) Traffic effects were small in terms of the total regional flow of trips, however there was major congestion on some freeways and arterials feeding the downtown area.
3) Automobile occupancy rates observed in the vicinity of downtown climbed from about 1.35 to 1.5 persons per car.
4) There were employment impacts.
5) Most hardest hit were transit dependent persons, particularly the low mobility groups such as the poor, elderly, and handicapped.
6) The fact that only 1 out of 15 residents of the 4-county district were directly affected by the strike (1 out of 10 in Greater Los Angeles County where 95% of the transit districts operations are concentrated) and post-strike patronage figures serve to indicate that a gradual recovery of most or all of the pre-strike ridership should occur.

On the following pages several other studies related to transit strikes are reviewed. Each examined the effect of a transit strike, however different investigatory techniques were utilized, and different variables were chosen as a basis for the evaluation.

It must be remembered that the analysis of a transit strike can tend to be subjective. While statistical methods and improved sampling techniques have quantified many prior subjective conclusions, the complexity of the problem still precludes a comprehensive investigation. These studies are being reviewed only to give an impression of strike effects as related to various urban areas. It is hoped that these case studies give the reader a better understanding of the influence strike-induced transit shutdowns may have on the short and long-run demand for mass transit services.

System Patronage vs. Strike Length[5]

Completed in the late 1960's by the consulting firm of Simpson and Curtin, the intent of this study (entitled "Impact of Strikes on Transit Riding") was to devise a method of forecasting passenger levels for use in applications to regulatory agencies.

An analysis of transit strikes by 18 different properties was conducted. This report concluded that there did exist a direct relationship between system ridership loss and strike length. A simple procedure was developed in the study to estimate this loss. A brief summary of the findings are given below:

1. For strikes of less than one week, there is no discernable permanent riding loss. There might be some immediate post-strike impact, but it generally does not last.
2. For strikes greater than one week in length, during the first two post-strike months permanent riding loss is estimated at 2% of the projected ridership for each week of the strikes duration. This loss is estimated at 1.5% per week of strike for the next 3 months, and 1% per week of strike for the balance of the first post-strike year.

3. The above figures are to be superimposed on the projected anticipated ridership, after allowing for projected increases or decreases due to other factors (such as economic trend or the impact of changed fares).

The Alameda-Contra Costa Transit Strike[6]

The Alameda-Contra Costa Transit District (AC Transit) and the Bay Area Rapid Transit District (BART) provide complementary transportation service to large sections of Alameda and Contra Costa counties. Results from an origin-destination survey taken on a typical June day in 1974 revealed the following ridership information: total patronage on AC Transit approached 200,000 trips/day of which 65,000 were transbay, 15,000 were access to BART, and the remaining 120,000 were made solely within its service area on the east side of San Francisco Bay. Approximately 28 BART stations are located within this region. Results from the survey indicated that of the 31,000 trips which exit from these BART stations daily, 7,500 are transfers to local AC Transit buses, and 1,500 are transfers to transbay AC Transit buses at the MacArthur BART station. Figure 3.1 illustrates the area of concern.

On July 1, 1974 AC Transit employees began a strike that was to last for 62 days. At this time only 2 BART services were in operation in the AC Transit area: Richmond-Freemont and Concord-MacArthur.

Through patronage and revenue counts, and from personal interview survey returns it was estimated that there were two basic ways in which the work stoppage affected BART patronage during the strike:

a. The cessation of feeder bus service at BART stations and transbay bus service at the MacArthur Station tended to reduce BART ridership.

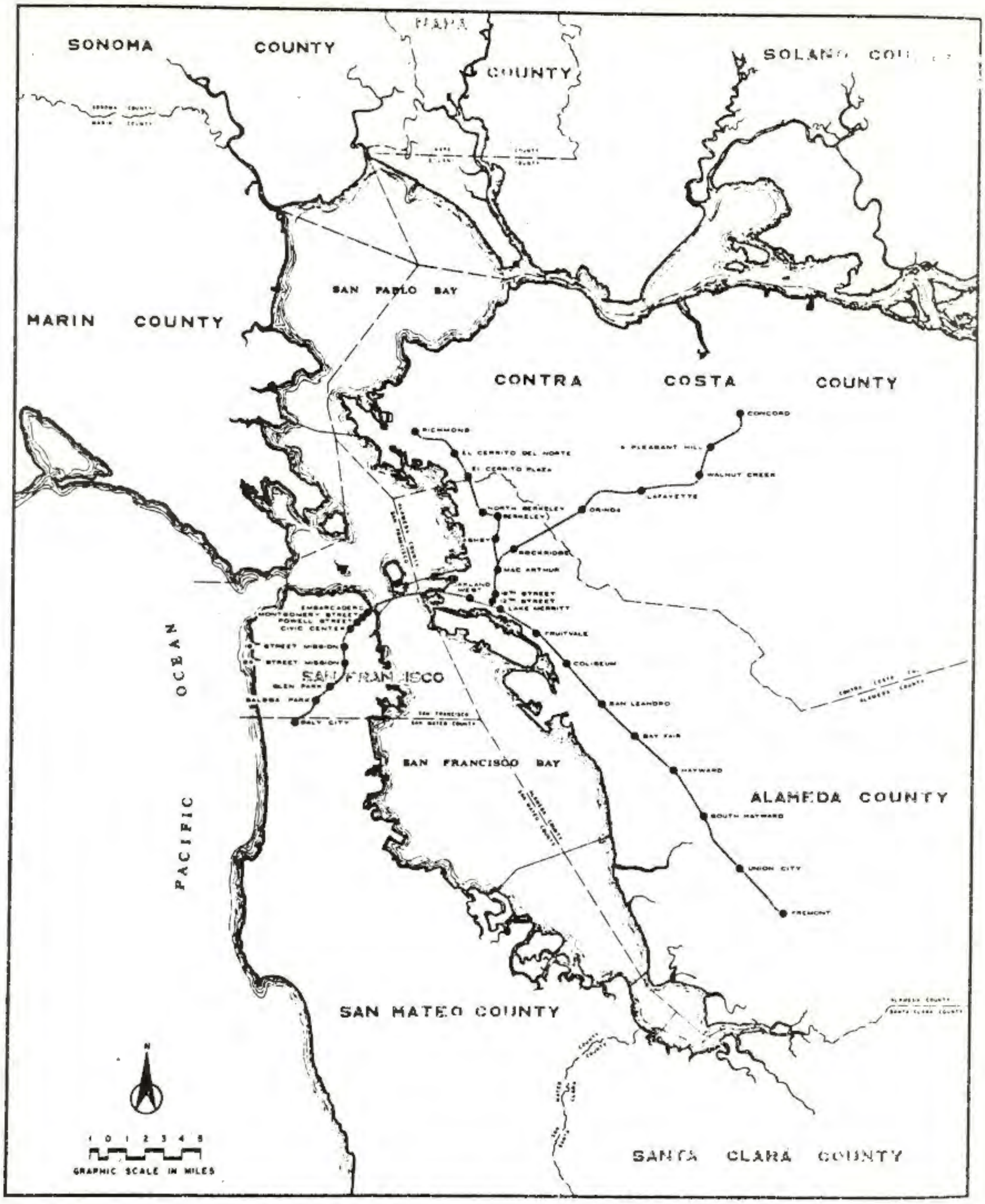

Figure 3.1. Bay Area Rapid Transit System

Source: Stephen G. Cohn and Raymond H. Ellis, Assessment of the Impacts of the AC Transit Strike upon BART San Francisco: Peat, Marwick, Mitchell & Co., 1975), p. 1

b. The cessation of AC Transit service on routes parallel to BART resulted in former bus travelers diverting to BART as an alternative mode.

During the strike there was a net increase in patronage on BART of 7% (2,600 trips) of which 12,000 trips were diverted from AC Transit, and about 9,400 trips normally taken on BART diverting to alternative modes. Fifty-one percent of the 15,000 feeder bus trips/day were continued on BART during the strike, 35% were suppressed, and 14% were diverted to another mode (principally the automobile). Additionally, of the 120,000 pre-strike AC Transit trips which were neither transbay nor feeder to BART, 10% were diverted to BART, 35% were suppressed, and 55% of these trips changed to other modes. Since transbay BART service was not initiated until 16 days after the strike settlement, of the 65,000 journeys across the bay normally taken on AC Transit, 14% were completely suppressed and 86% were diverted to the automobile during the strike.

Also during the strike there was a significant increase of 6% in average daily westbound vehicle trips on the San Francisco-Oakland Bay Bridge (from 92,600 veh. to 98,500 veh.). As a consequence some automobile traffic was diverted to other bridges, resulting in a 15% increase in traffic on the San Mateo-Hayward Bridge (from 14,800 to 17,100 average daily westbound veh.) and a 6% increase on the Richmond-San Rafael Bridge (from 10,800 to 11,500 average daily westbound vehicles). Greyhound patronage into San Francisco also significantly increased.

Twenty-one percent of the work trips normally taken on AC Transit were suppressed during service interruption. Contrasted with this is the 46-59% suppression rate of nonwork trips, largely due to the lack of a feasible alternative mode of transportation. Impacts on the elderly and the young were especially great, with 50-60% of their trips eliminated during the work stoppage.

Impact of the 1972 Transport of New Jersey Bus Strike[7]

Transport of New Jersey (TNJ) is considered the largest commuter bus operator of its kind in the Metropolitan New York area. Daily patronage on TNJ routes exceeds 350,000 riders, with more than 200,000 of these terminating or originating in Manhattan. The bulk of TNJ's market is from commuters living in one of the New York City oriented "bedroom" communities of Northern New Jersey (see Figure 3.2). In early spring, 1972, employees of TNJ declared a strike which interrupted service for 75 days. Due to the immense size of the TNJ system, the field of analysis was narrowed to include only those Trans-Hudson trips which entered the Manhattan CBD during the morning peak period (8 a.m.-9 a.m.), considered journey to work.

Records indicated a pre-strike ridership level during this time period of approximately 8000 commuters. A few weeks after settlement of the strike a second survey during the same period recorded trans-Hudson patronage as only 6400, a 20% decline. Upon investigation of other TNJ routes similar losses were revealed. This drop, even when the natural decline in commuter bus usage is considered (5.3% over the previous 11 year period for TNJ) was excessively large.

Survey results of a sample of Manhattan-bound commuters is illustrated in Table 3.1. As can be seen, competing modes experienced a significant increase in ridership. The distribution of this patronage among these transportation options was influenced by the location of individual origins and destinations, and by the mode choices available to the diverted commuters. Generally it was found that most passengers simply chose the mode most convenient to their individual needs. Additionally it was noted that areas with many alternative transportation services available yielded significantly different in-strike

Table 3.1. In-Strike Modal Use Based on a Sample of Manhattan-Bound Commuters

Mode	Pre-Strike Use	In-Strike Use	% Change
Other Bus	146	421	+188.4
Car-Pool	49	87	+ 77.6
Commuter Rail	161	261	+ 62.1
Automobile	155	212	+ 36.8
TNJ	464	---	---

Source: Andrew F. Bata, Effect of 1972 Trenton, New Jersey Bus Strike: 48, table 7.

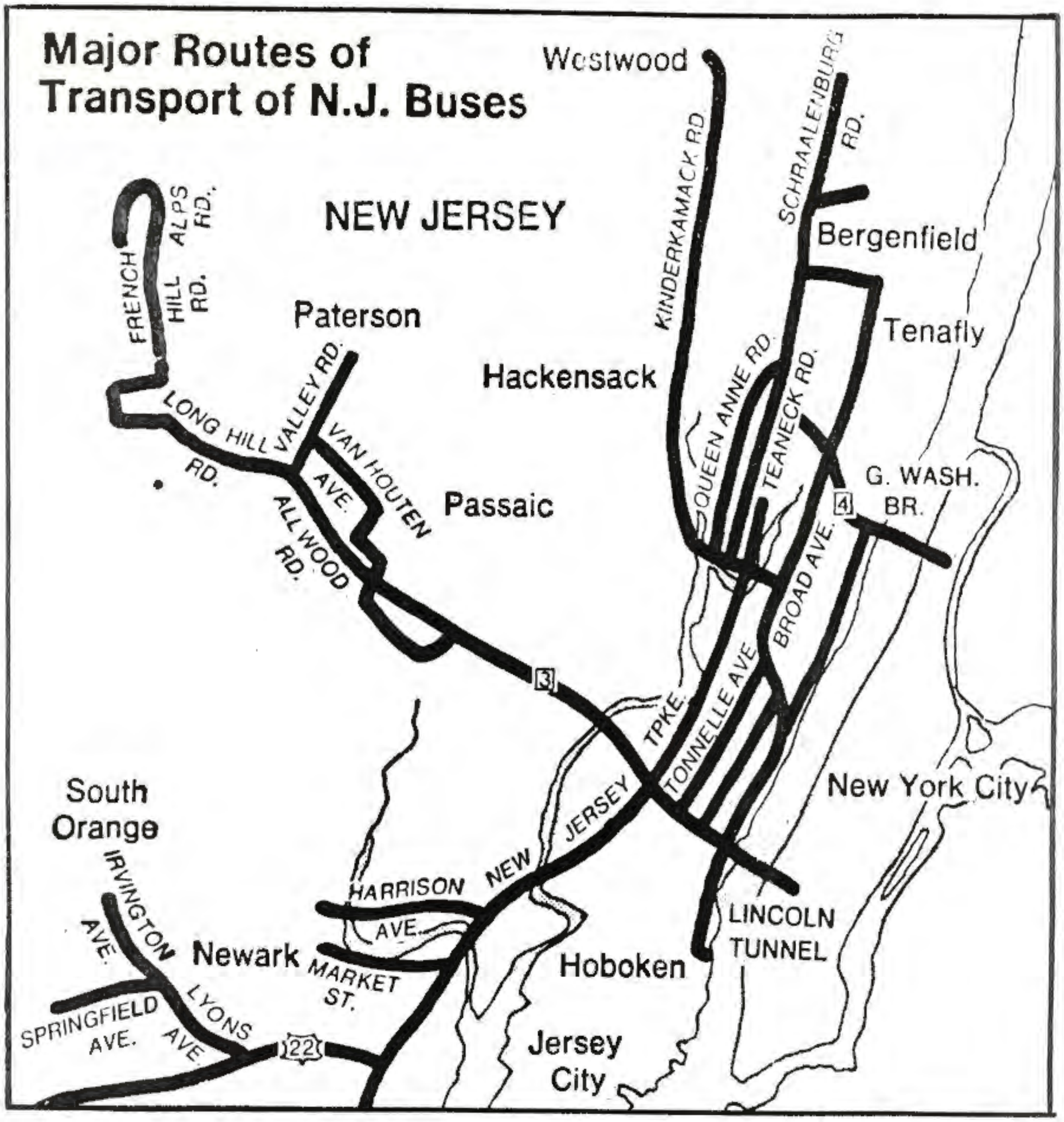

Figure 3.2. Major Routes of Transport of New Jersey Buses

Source: New York Times, 14 March 1976.

modal choices behavior by diverted TNJ patrons than would be anticipated for non-TNJ commuters (see Table 3.2).

As can be seen, during the strike there was a significant increase in the patronage of competing bus modes, and a marginally significant increase in total commuter rail usage. However, while more pre-strike TNJ commuters were initially attracted to the competing buses than to commuter rail, post-strike survey information has indicated that more rail users decided to remain with their new mode than did diverted patrons of competing bus facilities, or any other mode. Suprisingly, the automobile was the least popular alternative. Table 3.3 illustrates these results.

Survey analysis also indicated that permanent diversion was less where there had been a substantial pre-strike TNJ population, and was greater where TNJ usage had been only marginal. Additionally post-strike permanently diverted commuters were found to have behaved atypically of the general TNJ population when considering in-strike modal choice - they distributed themselves differently among the various modes than the temporarily diverted group. The permanent diversion group had a more similar in-strike mode-choice pattern to the population they had switched to rather than the population they had switched from.

It was also found that commuters from the permanently diverted group were significantly younger in age (by about 2 years) than the average age person in the survey data. Commuters who switched back to TNJ after completion of the strike were very close in age to the average. During the service interruption commuters who utilized car-pool or competing bus facilities were significantly older than the average population age; those that relied on railroad services were significantly younger.

Table 3.2. In-Strike Modal Choice of Pre-Strike TNJ and Non-TNJ Commuters Based on Sample of Manhattan-Bound Commuters

In-Strike Mode	Pre-Strike Mode	Pre-Strike Non-TNJ
Other Bus	274	147
Automobile	54	158
Car-Pool	38	49
Commuter Rail	98	163
Total	464	517

Source: Andrew F. Bata, Effect of 1972 Trenton, New Jersey Bus Strike: 52, table 9.

Table 3.3. Changes in the Modal Choice of Sample Manhattan-Bound Commuters

Mode	Pre-Strike	In-Strike	Post-Strike
TNJ Bus	480	---	413
Other Bus	146	421	170
Commuter Rail	161	261	189
Automobile	155	212	164
Car-Pool	49	87	55

Source: Andrew F. Bata, <u>Effect of 1972 Trenton, New Jersey Bus Strike</u>: 63, table 16.

The 1976 Golden Gate Transit Strike[8]

The Golden Gate Transit District operates both basic and commuter services between downtown San Francisco and points within Marin and Sonoma counties, where local service is also available. Figure 3.3 illustrates this service area. On Monday, April 12, 1976 employees of Golden Gate initiated a 64 day strike over issues related to the renewal of their employment contract. Strike effects upon the bay area were influenced by a work stoppage of certain San Francisco craft unions from March 31, to May 8, 1976 which resulted in a service interruption of the San Francisco Municipal Railway; and the beginning of school summer recess on June 10, 1976. Since the successful arbitration of this strike occurred only recently (June 14, 1976) immediate impact data of the work stoppage upon transbay commuter period patronage is the only information available at this time.

A few weeks prior to the strike several proposals were recommended in an attempt to minimize the impact of a service interruption, should it occur. Some of the more significant programs included a 24 hour carpooling switchboard established by the transit district to match drivers with riders; the opening to all traffic of exclusive bus lanes on Highway 101 and the bridge; increased ferry service; car-pool parking lots opened in downtown areas; and paratransit operations (such as private minibus and senior citizens organizations) adding runs to their daily schedules. The most notable scheme involved a toll suspension for any automobile crossing the Golden Gate Bridge with greater than three persons, from 6 a.m. to 10 a.m. on weekdays. (Approximately half way through the strike these hours were extended to 5 a.m. Upon settlement of the strike this toll-free operation was permanently established for all automobiles carrying three or more people between the hours of 6 a.m. and 10 a.m.).

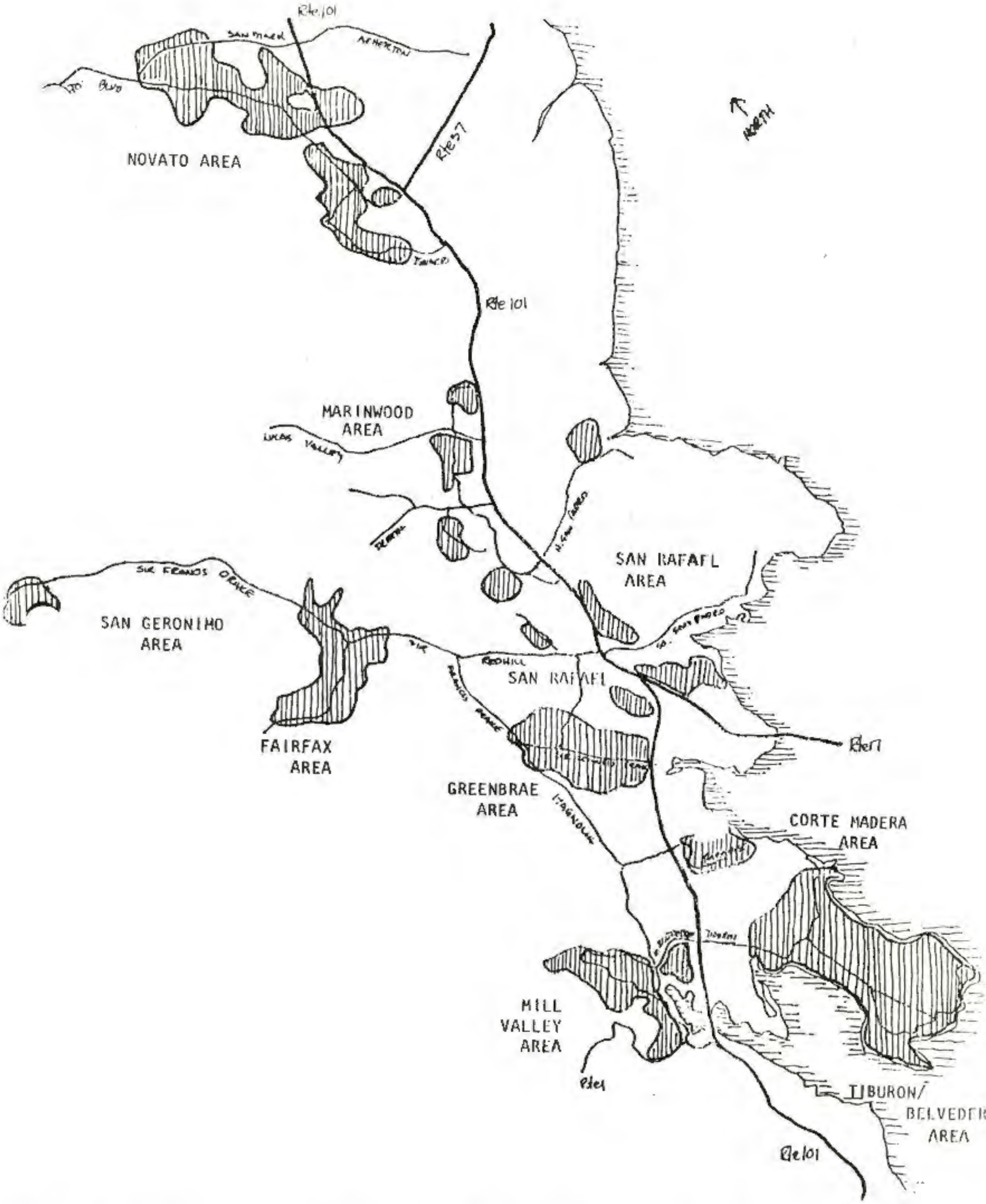

Figure 3.3. Service Area of the Golden Gate Transit District

Source: Marin County Transit District, "Impact of the Golden Gate Transit Guide Mailer and the Transit Strike", 1976. (Mimeographed), p. 4.

Table 3.4 illustrates vehicular counts on the southbound Golden Gate lanes before, during, and immediately after the strike. Note the variations in percent composition of one, two, and three passenger vehicles. Empirically the number of three-passenger car-pools appears to have significantly increased, even one month after settlement of the strike (qualitative data examined in a later section may help substantiate this observation). Naturally no long-term impact data is yet available.

This increase in car-pooling, initiated by a selective toll-free operating policy, may help explain some of the ridership loss experienced by Golden Gate Transit. This patronage decline is depicted in Table 3.5.

On May 14, 1976 (during the strike) a survey was commissioned in an effort to understand the increased car-pool utilization during the strike. Survey findings have indicated that 57% of the 278 respondents organized their carpools at work, with 44% of these patronized by former bus riders. Overall 65.5% of the carpools consisted of former bus patrons. Pre-strike automobile users accounted for only 9.3% of the total car-pool passenger volumes, pre-strike car-pool patrons totaled 25.4% of the respondents. It was also found that 35% of the carpools which contained solely pre-strike bus patrons were formed with neighbors.

Questionnaire data on post-strike travel behavior (from a survey of automobiles carrying greater than three persons, conducted at the Golden Gate toll plaza) revealed that a large percentage of former automobile users were willing to continue carpooling - a modal choice decision which is not strike dependent. In general all available informational sources point toward a steady number of post-strike toll-free car-pools. While at the present time there is no extensive long-term data available, it may be assumed that a significant number of pre-strike bus patrons

Table 3.4. Golden Gate Bridge Traffic Count; Southbound, 6 a.m. - 10 a.m.

Date	Total Veh.	Single Pass. Veh.	%	2 Pers. Per Veh.	%	3 or more Pers./Veh.	%
		PRE-STRIKE				(toll free carpools)	
1975							
Wed. 11/19	20,482*	15,303	75	4,053	20	890	5
Mon. 11/24	21,057*	15,970	76	3,977	19	873	5
Wed. 12/17	20,369*	15,220	75	4,043	20	875	5
Mon. 12/22	19,102*	13,856	73	4,003	21	1,012	6
1976							
Mon. 1/26	20,420*	15,270	75	4,065	20	850	5
Mon. 2/27	20,413*	15,368	76	4,017	20	797	4
Mon. 3/17	20,621*	15,334	75	4,243	21	812	4
Mon. 3/22	20,951*	15,356	74	4,384	21	980	5
Mon. 4/5	21,084*						
Tues. 4/6	20,772*						
Wed. 4/7	20,659*						
Thurs. 4/8	20,574*						
Fri. 4/9	20,471*						
Mon. 4/12		STRIKE BEGINS					
		DURING STRIKE					
Mon. 4/12	20,760	13,447	64.7	4,936	23	2,377	11.3
Tues. 4/13	21,011					2,752	
Wed. 4/14	21,599	13,977	64.7	4,911	22.7	2,711	12.6
Thurs. 4/15	21,653					3,011	

Table 3.4. Continued

Date	Total Veh.	Single Pass. Veh.	%	2 Pers. Per Veh.	%q	3 or more Pers./Veh.	%
Fri. 4/16	19,579					2,256	
Sat. 4/17	22,450						
Mon. 4/19	23,404	15,853	67.7	4,981	21	2,570	11.3
Tues. 4/20	22,942					2,730	
Wed. 4/21	22,705	15,451	68	4,774	21	2,480	11
Thurs. 4/22	22,768					2,528	
Fri. 4/23	22,641					2,486	
Mon. 4/26	22,919	15,475	67.5	4,957	21	2,487	10.9
. . . .							
Tues. 6/8	23,265						
Mon. 6/14		STRIKE SETTLEMENT					
		POST-STRIKE					
Tues. 6/15	21,195					≈2,000	
Wed. 6/16	20,150					1,661	
Tues. 6/22	19,786					1,749	
Wed. 6/23	19,587					1,646	
7/20	19,955	13,953	69.9	4,165	20.9	1,608	8.1

*Figures include an average of 230 buses.

Source: Marin County Transit District, "General Managers Report", April 30, 1976 (Mimeographed); The Independent Journal (San Francisco), 15, 23 April, 21 July, 1976.

Table 3.5. Golden Gate Transit Strike Impact on Bus Patronage*

Ave. Pre-Strike "Morning" Patronage:	9,200
Tues. 6/14/76	≈4,000
Wed. 6/16	6,545
Mon. 6/21	7,958
Tues. 6/22	7,478
Wed. 6/23	7,648
7/20	7,958

*Ridership count conducted on southbound lanes of Golden Gate Bridge.

Source: The Independent Journal, (San Francisco), 15, 23 June, 21 July, 1976.

have permanently diverted to car-pools. Several neutral questionnaire respondents indicated a desire to continue carpooling only if post-strike bus-fares increased.

A telephone interview program (conducted in May and June, 1976) of 291 households in selected Marin County neighborhoods revealed that 23% reported a definite adverse impact because of the strike, 11% reported some inconvenience, and 66% noted that they suffered little or no inconvenience. Forty-four percent of those respondents who were adversely affected by the strike replaced their pre-strike bus trips with an automobile trip, 21% car-pooled, and 16% suppressed their trips.

Strike Impact on Bus Ridership - A Stochastic Model[9]

On September 20, 1967 employees of the Madison Bus Company initiated a work stoppage which lasted for 63 days (until Nov. 21, 1967). As a representative middle sized community Madison, Wisconsin provided an ideal subject for the design of a time series stochastic model which could measure strike effects on bus ridership levels.

The methodology used, developed by Box and Jenkins (1970), provided a basis for forecasting transit demand if there were no service cessation. By comparing actual and forecasted post-strike demands, passenger losses attributed to the strike could be estimated.

The City of Madison, with a population of 173,356 (1970) is the capitol of Wisconsin, and the home of the University of Wisconsin-Madison (see Fig. 3.4). As a result, work and school trips account for a large percentage of the total transit ridership. The variables input into the model reflect this unique industrial and occupational makeup. These variables are: number of bus-miles operated, number of weekdays, number of college enrollment-schooldays, and the average adult fare; all for a given month.

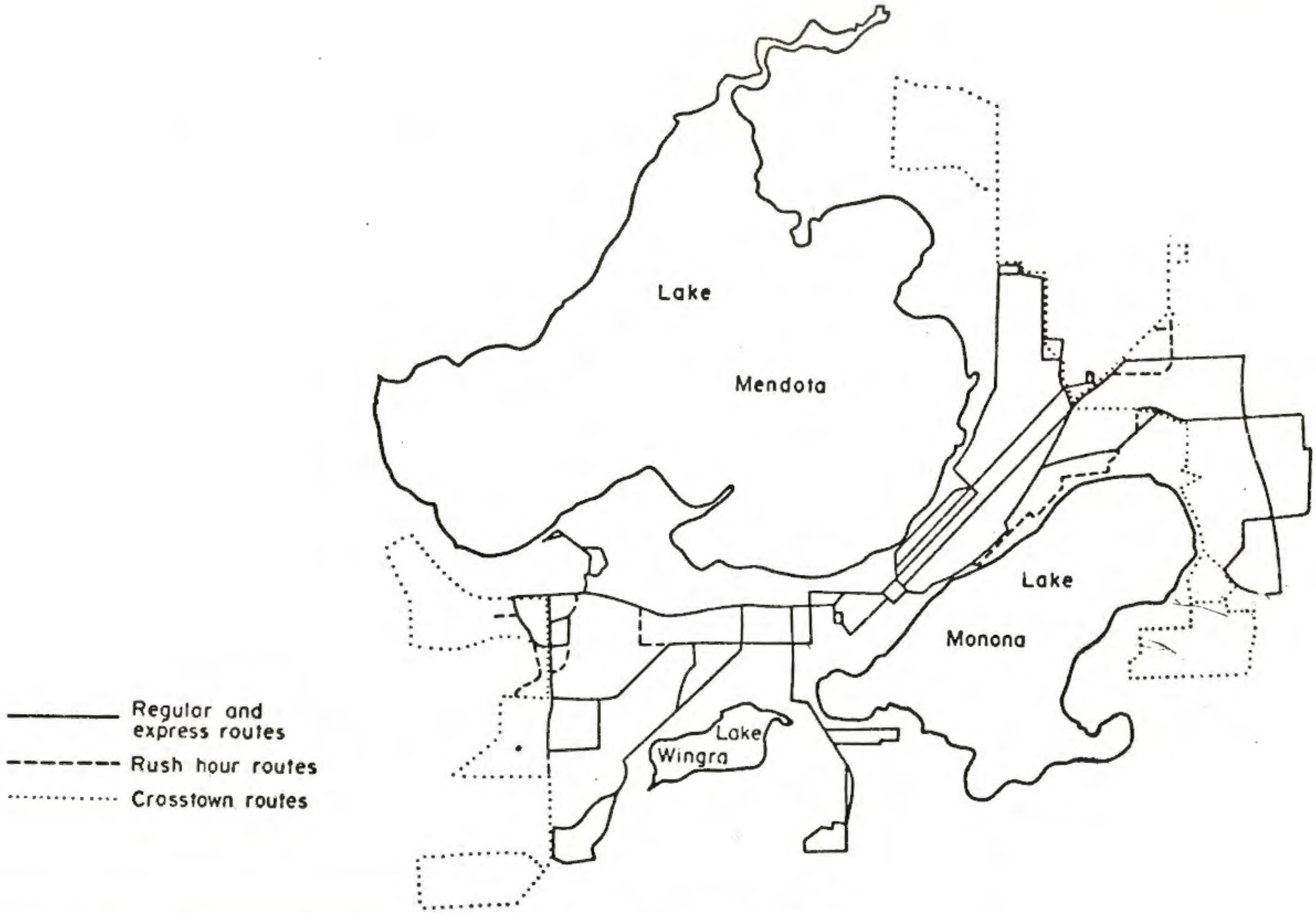

Figure 3.4. Routes of the Madison Bus Company (1965)

Source: Donald J. Harmatuck, "The Effects of a Service Interruption on Bus Ridership Levels in a Middle-Sized Community", Transportation Research, February 1975, p. 44.

This model indicated, with a fairly high degree of confidence, that ridership losses of 17.9 and 13.9 percent in the two years following the service interruption, had been caused solely by the strike.

Commentary on Case Studies

In this chapter several strike-induced transit shutdowns have been reviewed. A number of studies, utilizing many different data gathering techniques, have evaluated these work stoppages. Efforts have ranged from patronage, revenue, and traffic counts to personal interviews and mail-back questionnaires. The intent of this overview has been to summarize the available information on transit strikes and, particularly, to give the reader some idea of the difficulty involved in trying to fully assess transit strike impacts. Of the many variables and interactive elements which were outlined at the beginning of this chapter, their application varied widely. However, the majority of these studies did contain several similar concepts. These might be summarized as follows:

a. A transit shutdown does appear to exert an influence on post-strike system ridership. One study attempted to correlate patronage declines with strike duration, another with alternate mode incentives. Most certainly there are many other variables involved.

b. A transit strike has far-reaching impacts. Adjacent public transportation systems, existing paratransit options, automobile usage and occupancy, number of shopping and work trips, traffic congestion, even school attendance have been influenced to varying degrees.

c. Public transit recovery from a strike is also greatly dependent on many widely varying factors. Competition from alternative modes, diversion options and geographic location of pre-strike patrons, and individual user demographic characteristics are just a few.

d. Transit strikes exert an uneven influence on various socio-economic groups. The elderly, young, poor, and handicapped appear to be among the most severely affected.

Notes

1. Barrington and Company, The Effect of the 1966 New York City Transit Strike on the Travel Behavior of Regular Transit Users (New York: New York City Transit Authority, 1966), p. 1.

2. Barrington and Company, Effect of 1966 New York City Transit Strike, pp. 7-8.

3. J. L. Crain and S. D. Flynn, Southern California Rapid Transit District 1974 Strike Impact Study (Los Angeles: Bigelow-Crain Associates, 1975), p. 2.

4. J. L. Crain and S. D. Flynn, SCRTD Strike, p. 7-8; Los Angeles Times, 22 October-5 November, 1974.

5. Letter from John A. Dash, John A. Dash and Associates, Haverford, Pennsylvania, 22 January 1976, and John F. Curtin, Simpson and Curtin, Philadelphia, Pennsylvania, 29 July, 1976.

6. The majority of material presented here is drawn from the following BART publication: Stephen G. Cohn and Raymond H. Ellis, Assessment of the Impacts of the AC Transit Strike upon BART, (San Francisco: Peat, Marwick, Mitchell & Co., 1975).

7. A major part of the material presented in this section is drawn from the following publication: Andrew F. Bata, The Effect of the 1972 Trenton, New Jersey Bus Strike on the Modal Choice of the Commuters (Masters Dissertation, Northwestern University, 1974).

8. Material for this section was primarily drawn from the following sources: Richard Vicenti, "Golden Gate Bus Strike Carpool Survey", Stanford Graduate School of Business, 1976. (Mimeographed); Marin County Transit District, "Impact of the Golden Gate Transit Guide Mailer and the Transit Strike", 1976. (Mimeographed); Marin County Transit District, "General Managers Report", April 30, 1976. (Mimeographed); <u>The Independent Journal</u> (San Francisco), <u>The San Francisco Chronicle</u>, and <u>The Terra Linda News</u>, 10 April-21 July, 1976.

9. Material for this section drawn from: Donald J. Harmatuck, "The Effects of a Service Interruption on Bus Ridership Levels in a Middle-Sized Community", <u>Transportation Research</u>, February 1975, p. 43-54.

CHAPTER 4: SURVEY PREPARATION

Background

The effect of strike-induced transit shutdowns on the short and long-run demand for mass transit services is one of the major questions facing the industry today. While several impact studies have been completed relevant to a specific urban area, no comprehensive analysis of service interruptions across the United States has yet been undertaken. The survey, performed as a major part of this overall research effort, has been an attempt to fulfill this need.

In order to secure relevant information, the survey was designed from an empirical viewpoint. Upon recognizing that a detailed analysis of strike impacts on businesses, transit users, etc. was not feasible, the decision was made to seek out affected transit properties directly. By obtaining answers to such inquiries as pre- versus post-strike fares, route length alterations, and ridership volumes, it was expected that significant information regarding the influence of a service interruption would be obtained.

In the initial planning stages a judgement was also made concerning survey format. While early consideration was given to a questionnaire personal interview follow-up approach, the final decision was to use a mail-back questionnaire only. It was decided that such a method best lent itself to the logistics of the survey.

The general objective of this study has been to provide an overview of transit strike impacts. However, as the subject matter involved is very extensive, emphasis was given to the evaluation of strike effects as related to changes in system pricing and service variables.

Questionnaire Design

The population size of the area served by a transit system was chosen as an indication of whether survey investigation was warranted. A population cutoff point was derived, using a procedure which correlated transit properties to city population sizes. Bus Ride (an industry directory) maintains such a listing for all bus companies in the United States and Canada. While this includes intercity, urban transit, airport, school, sightseeing, tours, and charter operations, only urban transit organizations were considered.

This procedure is outlined as follows: initially population value ranges were determined. Any large relative differentials in the number of transit properties at each population category signalled possible cutoff points (see Table 4.1). Within the chosen ranges, these were found to be urban areas of 10,000, 40,000, and 80,000. For this study 40,000 was chosen. Where transit firms significant to the study were located in urban areas of less than 40,000 while servicing an area with a population greater than 40,000, they were included in the survey.

Upon selection of a subject population questionnaire design commenced. The initial step was to prepare a listing of variables which could be associated with transit strike effects. Upon review, several were eliminated due to ambiguity, or the anticipated difficulty in receiving a proper reply.

Table 4.1. Number of Transit Properties in Cities of Various Population Sizes (1974)

City Population	No. of Transit Properties	Difference
0 - 9,999	345	0
10,000 - 19,999	162	183*
20,000 - 29,999	102	60
30,000 - 39,999	96	6
40,000 - 49,999	58	38*
50,000 - 59,999	48	10
60,000 - 69,999	34	14
70,000 - 79,999	30	4
80,000 - 89,999	16	14*
90,000 - 99,999	14	2
100,000 - 109,999	15	-1
110,000 - 119,999	8	7
120,000 - 129,999	9	-1
130,000 - 139,999	11	-2
140,000 - 149,999	7	4
Greater or equal to 150,000	90	-83

*Possible population cutoff points.

Source: Adapted from BUS RIDE (Spokane, Wash., 1975); American Public Transit Association, 1976 Directory, (Washington, D.C.: APTA, 1976).

After several revisions, a pre-test questionnaire was sent out to eleven bus companies across Indiana. By confining the pre-test to Indiana it was hoped a rapid response might be achieved. Each survey packet was accompanied by a cover letter containing completion instructions, and offering background information. Comments were solicited. A self-addressed business reply envelope was enclosed for convenience.

Of the eleven transit properties pre-tested, only one had ever been subjected to a work stoppage, and even that was prior to a change of ownership (resulting in a loss of all records pertaining to the strike). Thus none of the pre-test questionnaires were filled out in their entirety, the end result being that they could not be tested adequately for simplicity and directness. However, comments which were received, plus additional review, provided the basis for a final questionnaire revision.

In its conclusive format the questionnaire reviewed a transit strike by monitoring several significant variables at various time periods before and after the shutdown. These included average adult fare, miles of route, vehicle-hours of operation, average daily ridership, and two service indices to be defined in the next chapter. The rationale behind this procedure was to observe the effect a transit strike might have on such variables.

Overall format was similar to that of the pre-test survey, return identification was facilitated by a numbering system. Also the questionnaires were designed so that properties which had not experienced a transit strike during the time period requested merely answered five questions on the first page. This design was an attempt to increase the response. Questionnaires, and the cover letter, are presented in the Appendix.

"Natural" Trends in the Industry

A problem which required major consideration was the time influence on ridership which might alter or obscure any empirical strike impacts. Optimally a complete history of individual system patronage would have been required to rectify this situation. Unfortunately the volume of data needed from each transit property would have certainly resulted in greatly decreased response rates. The need became evident for establishment of a simple fixed time reference against which questionnaire responses could be compared. Since all the data requested is not necessarily recorded by a transit property at all the same time, an additional problem was to find a methodology suitable for response coordination. In order to accomplish such a task while still maintaining a reasonably simple approach the following procedure was used: a "before strike" date was fixed as that most recent prior to the strike that any of the questionnaire variables had been recorded. This was labeled the reporting date. Naturally, as previously explained, not all data is collected at the same time by transit property personnel (collection may be on a daily, weekly, monthly, quarterly, or other basis). The simplifying assumption was made that this would not significantly influence the results.

The second major item on the questionnaire was a request for information immediately after the strike, the approximate collection date also being solicited. This gave another reference point fixed in time. The third data point was one year after the reporting date. If it was found that information had been collected longer than two months before or after a strike, or the 1 year reporting date was outside a $\pm$ 1 month tolerance, the individual response was eliminated from analysis

consideration. It should be noted here that these limits were arbitrarily chosen.

Thus three points in time have been isolated: "immediately" before the strike, "immediately" after the strike, and a one year "reporting date". Figure 4.1 illustrates this procedure.

While seasonal variations in the monitored variables could be controlled with the above methodology, it was very difficult to eliminate yearly industrywide trends such as ridership decline, increase (until very recently) in the average fare, etc. Control data was required from systems which had not been struck in at least the past fifteen years (the survey period chosen for this study). This would provide a comparative index in which industry-wide time-dependent trends could be revealed in the strike data, and thus eliminated.

Attempts at obtaining this information from several organizations met with failure because such data is only collected for all transit systems, regardless of whether they have experienced a strike or not. However, while it may be very difficult to eliminate natural yearly trends from the data obtained, it is possible to recognize their approximate size. For comparative purposes the mean percent change per year of several significant study variables is illustrated in Table 4.2. This information was calculated from industrywide bus transit data obtained for the last 15 years. These figures should be kept in mind when reviewing the questionnaire analysis.

Survey Procedure

On January 12, 1976, 354 survey packets were mailed to transit firms across the United States. After four months, approximately 40.1% completed or partially completed questionnaires had been received. Oue to a lack

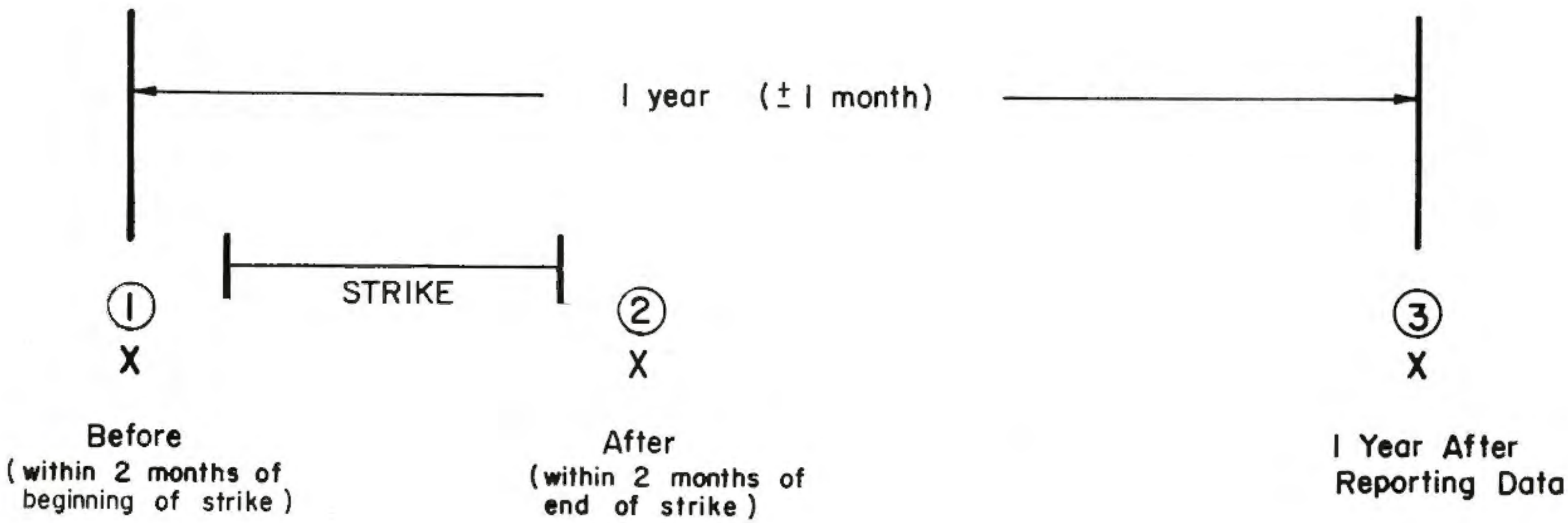

FIGURE 4.1, CONSIDERATION OF TIME TREND

Table 4.2. Trends in the Transit Industry

Variable	Mean % Change/Year (1961-1975)
Total Bus Transit Passengers	-2.09%
Average Bus Fare	+3.76%
Bus Passenger Vehicle-Miles Operated	- .04%

Source: American Public Transit Association. Statistical Department, Transit Fact Book (Washington, D. C.: APTA, 1976), pp. 32, 36, 42.

of response from several significant properties this return was not considered adequate for evaluative purposes. Consequently on May 12, 1976 there was a second mailing. Questionnaires were re-sent to 62 randomly chosen transit companies, and also to 23 additional properties found in a more recent APTA directory which had not been in the previous sample. This brought the total population size up to 377.

Forty-three questionnaires from this second mailing were received, bringing the total response up to its present 49.1%, an excellent figure for the mail-back procedure employed. It is worth mentioning, however, that the ease with which properties that had not experienced a strike could complete and return the questionnaires would appear to bias the results in their favor. Analysis has indicated that 28.1% of the returns were from those companies which had suffered a work stoppage in the last fifteen years.

Data Analysis Procedure

Survey analysis was accomplished through the use of a set of computer routines known as the Statistical Package for the Social Sciences (SPSS).[1] SPSS is an integrated program system which can be used in the analysis of social science data. This system was designed to allow many different procedures to be performed in a simple and convenient manner. There is a great deal of formatting flexibility, and the user is provided with a comprehensive set of statistical routines useful for data transformation. In the coding process, each possible response is assigned a variable name corresponding to the information it is meant to convey. In addition responses are also correlated to numerical codes in order to facilitate the transfer of data from questionnaire to computer card. While response

coding is relatively straight-forward for such questions as number of strikes, a population size, usually a number key must be constructed to cope with such variables as day of the week, or transit property management type. SPSS enables the researcher to perform his investigation through the use of natural language control statements. Frequencies, Scattergrams, ANOVA, and regression packages were freely used throughout the course of this analysis.

Additional statistical packages were also utilized from the Purdue University computer center library. All data manipulation programs were written by the author.

Remarks on Survey Procedure

While a rigorous procedure was utilized in attempting to design an adequate questionnaire, several difficulties did become apparent upon examination of the survey returns. Additional problems were brought to the attention of the study team from comments offered by several respondents.

Some problems did occur because of the non-specificity of several questions. While conciseness was recognized as critical to the analysis, and a special effort was made to design for this, the uncertainty about the type of data collected and recorded by different transit systems led to a few problems. Average daily ridership returns were sometimes given in total, sometimes in revenue passenger figures; strike duration was recorded in either operating days, working days, or total days; and miles of route could be either one-way or two-way. Consequently, whenever apparently incorrect questionnaire replies could not be verified, they were simply eliminated from further analysis consideration.

Several respondents also submitted suggestions for questionnaire improvements. One comment was that, since many properties probably do not maintain route mileage

records, a request for historical records on weekly scheduled miles (more readily available as they are considered necessary for budgetary projections and mileage costing) might be more appropriate.

Another suggestion was in response to the request for transit ridership figures at critical times during a typical day. The difficulty mentioned was, unless a system is very small or a larger one had either passenger counters or computer capability, it would be very difficult to supply an answer in the format desired. This did happen, as the majority of responses were in units of average total daily ridership, necessitating a revision in the analysis procedure.

The alternative which was offered involves a count of the number of base and peak service vehicles in operation during the time periods requested (most systems should have accurate records as to vehicle utilization). Records of daily passengers off of the farebox (usually maintained by systems with greater than 30-40 coaches) can be applied towards the vehicle utilization records in order to establish numbers of passengers during the time periods of interest. Periodic surveys which are taken can be used to establish percentages of school children, senior citizens, transfer passengers, etc.

Another respondent suggested that the impact of a transit strike would be best measured promptly, rather than waiting until a year after the strike for comparison's sake as used in this study. The reasoning behind this was the feeling that measurement of a long-term impact was hazardous at best because of the intervening effect of changes in economic, environmental, and other conditions.

Another difficulty worth mentioning was the inability of several companies to furnish the data as requested. Many properties lacked the staffing and/or the financial

resources necessary to carry out the required investigative effort. One respondent commented, "I am sure you must be reading in the newspaper about the financial problems in the East ... unfortunately planners and research types are the first to go." Another noted that they found "... that much of the information you require is impossible to furnish and would cost ... a considerable sum of money to conduct the research for getting."

In all cases data considered inaccurate, or survey responses that could not be used, were eliminated from further analysis consideration. In the next chapter all survey table results include the number of respondents from which usable information was obtained, and should be considered highly reliable.

Notes

1. A complete discussion of SPSS capabilities is available from: Norman H. Nie et al., Statistical Package for the Social Sciences, 2nd ed. (New York: McGraw-Hill Book Company, 1975).

CHAPTER 5: INDUSTRYWIDE RESULTS AND ANALYSIS

Introduction

As discussed in Chapter 4, the study questionnaire was designed to review a transit strike by monitoring several variables at various time periods before and after the service interruption. While there are many factors which might influence or measure the impact of a service loss to transit patrons, in the interest of securing significant results within available resources six main service and demand variables were chosen. In Table 5.1 is given a list of mnemonic symbols representing those variables which were used in the analysis, including those defined and those derived.

Variable Interrelationships

One of the goals of this study was to determine the interaction among such variables as fare, vehicle-hours, miles of route, and ridership as the direct result of a strike situation. Several research studies in the past have explored these relationships under nonstrike situations, most notably the correlation between fare and changes in system patronage as discussed in Chapter 1.

This example was introduced to give the reader an idea of the problem associated with defining one variable as dependent on the change in another. The Simpson and Curtin study empirically found a direct relationship between fare increase and ridership decrease.[1] However, the Urban Institute study noted that the change in ridership is more significantly sensitive to changes in

Table 5.1. Variables Used in the Survey Analysis

Variable Name	Definition
POPULATN	service area population size
AREA	transit system (city) under investigation
BUSRIDER	present average weekly ridership
MANAGER	management type
STRIKE	indication of strike occurrence
NUMSTRIK	number of strikes experienced by the system of concern in the past 15 years.
DURATION	duration of most recent strike in days
REPORTING DATE	the most recent date prior to the strike that any of the pre-strike data was collected
BBUSFARE	pre-strike average adult fare of system (measured within 2 months of beginning of strike under investigation)
BBUSMILE	pre-strike total one-way miles of route (measured within 2 months of beginning of strike under investigation)
BBUSHRS	pre-strike total vehicle-hours of operation per week (measured within 2 months of beginning of strike under investigation)
BBUSAVEV	pre-strike average daily ridership of transit system (measured within 2 months of beginning of strike under investigation)
IABUSFAR IABUSMIL IABUSHRS IABUSAVV	post-strike variables for fare, mileage, vehicle-hours, and ridership (measured within 2 months of end of strike under investigation)

Table 5.1. Continued

Variable	Definition
YABUSFAR YABUSMIL YABUSHRS YABUSAVV	post-strike variables for fare, mileage, vehicle-hours, and ridership (measured one year after the reporting date)
ICHNGFAR	percent change in average adult fare before (within 2 months) and immediately after (within 2 months) strike under investigation. Defined as follows: $ICHNGFAR = \frac{BBUSFARE-IABUSFAR}{BBUSFARE}$
ICHNGMIL	percent change in one-way route miles before (within 2 months) and immediately after (within 2 months) strike under investigation. $ICHNGMIL = \frac{BBUSMILE-IABUSMIL}{BBUSMILE}$
ICHNGRID	percent change in average daily ridership before (within 2 months) and immediately after (within 2 months) strike under investigation. $ICHNGRID = \frac{BBUSAVEV-IABUSAVV}{BBUSAVEV}$
ICHNGHRS	percent change in total vehicle hours of operation per week before (within 2 months) and immediately after (within 2 months) strike under investigation. $ICHNGHRS = \frac{BBUSHRS-IABUSHRS}{BBUSHRS}$
YCHNGFAR YCHNGMIL YCHNGRID YCHNGHRS	percent change variables for fare, mileage, vehicle-hours, and ridership. Their respective measurements are before (within 2 months) the strike under investigation, and one year after the reporting date within a tolerance of $\pm$ 1 month. They are defined as follows:

Table 5.1. Continued

Variable Name	Definition
	$YCHNGFAR = \frac{BBUSFARE-YABUSFAR}{BBUSFARE}$
	$YCHNGMIL = \frac{BBUSMILE-YABUSMIL}{BBUSMILE}$
	$YCHNGRID = \frac{BBUSAVEV-YABUSAVV}{BBUSAVEV}$
	$YCHNGHRS = \frac{BBUSHRS-YABUSHRS}{BBUSHRS}$
IMARKET YMARKET	a derived service index which normalizes transit ridership according to the service area of a system. As a per capita ridership measure, it gives an indication of the impact a strike may have on the transit market. Units are % change in ridership/population. $IMARKET = \frac{BBUSAVEV-IABUSAVV}{POPULATN} *100$ $YMARKET = \frac{BBUSAVEV-YABUSAVV}{POPULATN} *100$
ISERVICE YSERVICE	a derived index which indicates the level of service offered to transit patrons. As the indice becomes more negative it indicates either an increase in vehicle hours of operation, a decrease in the miles of route of a system, or a combination of both. This would be reflected in shorter headways between vehicles on the routes, or an increase in the average number of buses in service during the day. This is considered increased service to the transit consumer due to diminished waiting times, improved transfer opportunities, longer hours of operation, etc.

Table 5.1. Continued

Variable Name	Definition
	An increase in the miles of route, decrease in the vehicle hours of operation, or a combination of both would make the index more positive. This indicates a decrease in service, reflected in increased user waiting times, shorter hours of operation, lessened transfer opportunities, etc. Units are $\frac{\text{\% change in veh.-hrs. of operation}}{\text{\% change in miles of route}}$ $ISERVICE = \frac{ICHNGHRS}{(1-ICHNGMIL)}$ $YSERVICE = \frac{YCHNGHRS}{(1-YCHNGMIL)}$

the level of service offered by the transit system.[2]

Upon introduction of a strike situation causal relationships get much more complex. Hypothetically a post-strike fare increase may have been due to a highly labor-favorable contract settlement which necessitated increased revenues to cover higher operating costs. In this case any resultant ridership change may have been dependent on the fare increase. Conversely, a sharp patronage decrease due to the strike may have induced management to raise fares. This would lead one to believe that the fare change was dependent on a ridership decrease. This problem is magnified when the attendant effect of other variables is included.

One possible methodology to circumvent this problem would have been to determine exact dates of any mileage, vehicle-hour, and fare changes for subject transit systems. Unfortunately the resulting burden on respondents was considered too great.

While there are several statistical methods available for causal interpretation (most notably PATH analysis[3]) to expedite questionnaire review the following three assumptions were made:

1. Service area population size, management type, and the fact that there was a strike were considered independent.
2. All other variables were considered dependent.
3. The change in a service variable immediately after a strike was considered independent of the change in the variable one year after the strike.

Questionnaire Results

Tables 5.2 and 5.3, illustrated on the next several pages, contain all information procured directly from the questionnaire, or derived for use during analysis. This data broadly summarizes the survey information. Unstarred variables are for the entire survey group which responded. It should be noted that in the actual analysis not all this data could be used. Only the starred variables in Table 5.2 were utilized in the analysis discussed on the following pages.

As can be seen from Table 5.3 in both strike and non-strike categories the largest survey returns were from publicly owned systems. However private companies accounted for a greater percentage of the nonstruck properties. This relationship will be discussed in a later section.

Generally it should be noted that data received covered an extreme range. System size varied from 1000 riders/week to 10,000,000 riders/week. It seems highly unlikely that properties with such dissimiliar characteristics would react in the same manner to a transit strike. This was one of the major reasons that the particular analysis methodology, discussed in the next section, was chosen.

Statistical Methodology

After careful consideration it was decided that Analysis of Variance (ANOVA) techniques best lent themselves to fullest utilization of the questionnaire data. ANOVA is merely a procedure whereby the total variation in the dependent variable is subdivided into meaningful components which are then observed and treated in a systematic fashion (these "meaningful components" are the independent variables which were previously defined). An ANOVA table is a summary of dependent variable variation,

Table 5.2. Questionnaire Results

A) Systems struck at least once in the last 15 years; Data from most recent strike.

Variable Name	Sample Size	Mean	Maximum	Minimum
*POPULATN	47	1,317,583	10,000,000	38,559
*BUSRIDER	43	779,470	7,455,955	8,000
*NUMSTRIK	43	2.2	11	1
*DURATION (days)	43	34.1	273	<1
BBUSFARE ($)	33	.38	1.92	.14
IABUSFAR ($)	29	.31	1.00	.11
YABUSFAR ($)	20	.38	1.92	.15
*ICHNGFAR (%)	27	+6.32	+50.00	-16.67
*BBUSFARE ($)	--	.33	1.00	.14
*IABUSFAR ($)	--	.31	1.00	.11
*YCHNGFAR (%)	19	+16.32	+50.00	-16.67
*BBUSFARE ($)	--	.40	1.92	.14
*YABUSFARE ($)	--	.39	1.92	.15
BBUSHRS	23	31,301	100,000	458
IABUSHRS	21	23,164	100,000	350
YABUSHRS	17	24,158	100,000	397
*ICHNGHRS (%)	19	-13.74	+7.20	-9.94
*BBUSHRS	--	30,170	100,000	458
*IABUSHRS	--	25,336	100,000	350

Table 5.2. Continued

Variable Name	Sample Size	Mean	Maximum	Minimum
*YCHNGHRS (%)	16	-5.03	+8.50	-37.50
*BBUSHRS	--	26,648	100,000	458
*YABUSHRS	--	25,427	100,000	397
BBUSAVEV	19	271,638	1,439,900	2200
IABUSAVV	19	241,762	1,306,000	1300
YABUSAVV	15	268,484	1,201,500	2000
*ICHNGRID (%)	18	-18.62	+8.1	-79.4
*BBUSAVEV	--	275,888	1,439,900	2200
*IABUSAVV	--	246,890	1,306,000	1300
*YCHNGRID (%)	15	-4.31	+34.8	-22.8
*BBUSAVEV	--	311,061	1,439,900	2200
*YABUSAVV	--	268,484	1,201,500	2000
*ICHNGMIL (%)	24	-1.62	+19.8	-33.3
*YCHNGMIL (%)	19	+1.29	+21.1	-16.7
*IMARKET	18	-3.04	+.146	-10.20
*YMARKET	15	-3.37	+1.74	-21.86
*ISERVICE	19	-.156	+.072	-.994
*YSERVICE	16	-.056	+.084	-.450

Table 5.2. Continued

Variable Name	Sample Size	Mean	Maximum	Minimum
B) Systems not struck in last 15 years				
POPULATN	121	510,998	8,040,000	20,000
BUSRIDER	118	198,101	10,000,000	1,000

*Variables Used in Analysis.

Table 5.3. Management Type for Struck and Non-Struck Systems

Management Type	Strike: Sample Size	Strike: % of group	Non-Strike: Sample Size	Non-Strike: % of group
Private Company	7	14.9	30	24.8
Local Government with Own Personnel	7	14.9	37	30.6
Autonomous Authority with Own Personnel	18	38.3	26	21.5
Contract Management	13	27.7	20	16.5
Other	2	4.3	8	6.6
Total	47	100.0%	121	100.0%

mathematically defined as the sum of squares, associated with its various possible sources. The F statistic will be used as a test of significance.

If the computed F exceeds the critical F value (dependent on the α-level chosen) then it can be concluded that there is a significant amount of variation in the dependent variable, and that it is accounted for by the ANOVA model chosen. Conversely, if the F statistic is not significant, it can be concluded that the data did not reflect sufficient evidence to support the postulated model.

An α-level of .10 was chosen for all statistical tests: α is the probability of stating that there is a significant amount of variation in the dependent variable when in fact there is not.

In order to fill adequately all ANOVA table cells, two procedures were followed. First, only three independent variables were utilized at any one time. Additional variables would have created more cells than data points to fill them. Second, service area population size, strike duration, and management type were aggregated into several groups. Crosstabulations were run against the dependent variables. Group number and sizes which gave the optimum data spread, while still maintaining fairly logical class sizes, were chosen. These are illustrated in Table 5.4.

There are three major assumptions which must be met in order to utilize ANOVA techniques: experimental errors must follow a normal distribution, have homogeneous variance for each cell, and are statistically independent (implying that, in general, a strike in one city does not significantly influence the performance of a company in a different city). Satisfaction of the normal population requirements was accomplished with the Shapiro-Wilk Test. Cochran's C and the Bartlett-Box F statistics were used in meeting homogeneous variance requirements.

Table 5.4. Population, Management, and Strike Duration Class Sizes

Group No.	Population Limits (Number of People)
1	40,000 - 360,000
2	360,001 - 1,499,999
3	1,500,000 and greater
Group No.	**Management Type**
1	Private Companies
2	Public Companies
Group No.	**Strike Duration (Days)**
1	0 - 10
2	11 - 25
3	26 - 50
4	51 and greater

In order to satisfy the above assumptions several variables were transformed into different forms as illustrated in Table 5.5. The rest of the variables were used directly in the analysis.

Significant variables were tested for differences in group means, using the Duncan-Bonnor Range Test. Additionally, the Chi-Square procedure was used when testing for any interrelationship among the independent variables.

Mention should be made here of the ramifications when calculated F statistics are much less than 1. Usually this may indicate that the underlying assumptions of normality, homogeneity of variance, and independence have not been met; or that the assumed model may not be a good approximation to the true state of affairs.

The most likely problem stems from difficulties in employing proper randomization and sampling techniques. The questionnaire was sent to every transit property within the population range defined in Chapter 3. However not all subject firms replied. Thus there may be hidden bias due to a greater tendency for smaller, larger, struck or nonstruck transit properties to return their surveys. Also, it may be entirely possible that the assumed linear model was not even a good approximation to the true state of affairs. As noted previously, the choice of dependency and independency was not based on mathematical procedure, but on logic. However there seemed no reasonable alternative to the procedures and models used.

At this time mention should be made as to what population the survey results will apply. While in a strict sense study conclusions should apply only to the population of questionnaire respondents, it is believed that they can be extrapolated to the entire industry. It can be reasonably assumed that the sample systems used in the analysis were representative of the entire industry. Thus,

Table 5.5. Variable Transformation

Algebraic Expression	Transformation
TPNUMSTR=SQRT(1+NUMSTRIK)	Poisson
TNBUSRID=LN(BUSRIDER)	Natural logarithmic
TNDURATI=LN(DURATION)	Natural logarithmic
TIYSERVE=(1/YSERVICE)	Inverse

the results reflect the strike status of the industry from 1961-1976.

ANOVA Models

Excluding the regression analysis discussed at the end of this chapter, two basic models were used. The first was a repeated measure method. In this approach each system was considered separately, resulting in only one observation per cell. The following model illustrates the above procedure:

$$Y_{ijk\ell} = \mu + P_i + M_j + PM_{ij} + C_{(ij)k} + \delta_{(ijk)} + T_\ell$$

$$+ PT_{i\ell} + MT_{j\ell} + PMT_{ij\ell} + CT_{(ij)k\ell} + \varepsilon_{(ijk\ell)}$$

$i = 1,2,3$
$j = 1,2$
$k = 1,2,\ldots\ldots, n_{ij}$
$\ell = 1,2$

where:

Y = dependent variable under consideration
μ = overall mean
P_i = i^{th} service area population size
M_j = j^{th} management type
C_k = k^{th} company (area) within $(i,j)^{th}$ population-management combination
T_ℓ = time indicator (reflects strike influence before, immediately after, and one year after strike).
δ and ε = error terms (df=0).

The ANOVA Table (illustrated in Table 5.6) was constructed from seven smaller ANOVA's in order that company effects could be isolated.

Table 5.6. ANOVA Table, Model A

Source	DF	MS	F
Population	2	MS_p	MS_p/MS_c
Management	1	MS_m	MS_m/MS_c
Population-Management Interaction	2	MS_{pm}	MS_{pm}/MS_c
Companies	varying	MS_c	
δ (error)	0		
Time	1	MS_t	MS_t/MS_{ct}
Population-Time Interaction	2	MS_{pt}	MS_{pt}/MS_{ct}
Management-Time Interaction	1	MS_{mt}	MS_{mt}/MS_{ct}
Population-Management-Time Interaction	2	MS_{pmt}	MS_{pmt}/MS_{ct}
Companies-Time Interaction	varying	MS_{ct}	
ε (error)	0		

Because there was only one data point per cell, underlying normality and variance conditions could not be tested, and thus were assumed.

A second, simpler, technique was also used. It involved models of the general type illustrated below:

$$Y = \mu + A_i + B_j + AB_{ij} + D_k + AD_{ik} + BD_{jk} + ABD_{ijk} + \varepsilon$$

$i = 1, \ldots, a$
$j = 1, \ldots, b$
$k = 1, \ldots, d$

Y = dependent variable under consideration
μ = overall mean
A, B, and D = independent variables under analysis consideration
ε = error term.

This was not a "repeated measures" approach, as it considered only one measurement per transit property (defined as the percent change variables "ICHNG" and YCHNG" in Table 5.1). System effects were not considered separately in this model. Because there is now greater than one data point per cell, normality and variance assumptions had to be satisfied using the techniques and transformations discussed earlier. In Table 5.7 is illustrated the resulting ANOVA table.

Generally, the model A approach was utilized in finding the effect of strike, service area population, and management type on changes in average fare, vehicle-hours of operation, average daily ridership, and market index before, immediately after, and one year after the strike. This technique employed actual questionnaire data. The Model B approach was used in all other cases, and employed the percent change variables derived in the previous section.

Table 5.7. ANOVA Table, Model B

Source	DF	MS	F
Independent Variable A	var.	MS_A	MS_A/MS_ε
Independent Variable B	var.	MS_B	MS_B/MS_ε
Independent Variable C	var.	MS_C	MS_C/MS_ε
A-B Interaction	var.	MS_{AB}	
A-C Interaction	var.	MS_{AC}	
A-B-C Interaction	var.	MS_{ABC}	
ε (error term)	var.	MS_ε	

The next several sections contain an analysis of transit strike effects, variable by variable.

Influence of Service Area Population Size and Management Type on Strike Potential

A Chi-Square procedure was used to explore the interrelationship between management type, service area population size, and strike probability. In order to provide both short and long-term estimates separate analyses were performed over the time periods 1961-1976, and 1971-1976. Strike probability is defined as follows:

$$\frac{\text{No. of Companies Struck/15 Yrs.}}{\text{Total No. of Companies Reporting}}$$

$$\frac{\text{No. of Companies Struck/5 Yrs.}}{\text{Total No. of Companies Reporting}}$$

These values were calculated for each population and management grouping. Table 5.8 summarizes the data used in this analysis. Table 5.9 presents the Chi-Square (X^2) values obtained.

It should be noted that when management type was varied all X^2 were significant; when service area population size was varied all X^2 were not significant. Additionally, a non-significant X^2 value indicated that management type does not significantly change with a population increase. These results were noted for both the fifteen year and the five year data.[5]

The above discussion leads to the conclusion that there are no interactive effects between population size and management type (under a strike situation) which might influence the results. The Chi-Square tests also indicated that the probability of a strike is significantly influenced by service area population size, but not by management type.

Table 5.8. Relationship Between Population and Management Type Under a Strike Situation

Population	Private Management 40,000-360,000	Private Management 360,001-1,499,999	Private Management 1,500,000 & Greater	Public Management 40,000-360,000	Public Management 360,001-1,499,999	Public Management 1,500,000 & Greater
Strike (January, 1961-June, 1976)	12	4	4	9	10	8
Strike (January, 1971-June, 1976)	9	3	2	6	5	5
Nonstrike	35	14	1	57	9	5

Table 5.9. Comparative Chi-Square Tests of Strike Occurrence, Service Area Population Size, and System Management

Analysis	χ^2	df	Significance
Long Term (1961-1976)			
Management Varies - private	7.048	2	.030*
- public	19.913	2	<.001*
Population Varies - 40,000-360,000	1.841	1	.175
- 360,001-1,499,999	2.456	1	.117
- 1,500,000 and greater	.554	1	>.1
Strike vs. Population	20.105	2	<.001*
Strike vs. Management	.001	1	.977
Management vs. Population	2.171	2	.338
Short Term (1971-1976)			
Management Varies - private	3.752	2	.153
- public	12.757	2	.002*
Population Varies - 40,000-360,000	1.741	1	.187
- 360,001-1,499,999	.535	1	.464
- 1,500,000 and greater	.258	1	>.1
Strike vs. Population	12.414	2	.002*
Strike vs. Management	.105	1	.746
Management vs. Population	4.023	2	.134

* Significant at α = .1.

On the basis of these two findings Figures 5.1 and 5.2 could be drawn. Figure 5.1 illustrates strike probability calculated from 15 year data, Figure 5.2 illustrates strike probability calculated from 5 year data. A close similarity between these two graphs can be noted.

It should be seen that as service area population size increases, the probability of a strike also increases for both time periods. Since management type does not significantly change with a population increase, it can be stated that the probability of a strike significantly increases as the service area population size increases, regardless of system management type. The next section will show that system size correlates quite highly with service area population size. At this point it can be concluded that the probability of a strike significantly increases as system size increases, regardless of management type.

Reasoning behind this is that a more extensive system (and the larger work force associated with it) might result in stronger unions, a poorer relationship or less communication with management personnel, and a more impersonal work situation (less familiarity with passengers, other employees, or management). Additionally management of a larger system might institute different bargaining procedures, or be constrained by a different political situation, or be less sensitive to a strike impact on its service area than management of a smaller system.

Relationship Between System Size and Strike Potential

While the previous analysis showed that larger service area population sizes have a greater strike probability, this section attempts to establish a relationship between system size and its chance for a strike. Table 5.10 summarizes data obtained from the questionnaires, and

Table 5.10. Current Weekly Ridership for Various Population, Management, and Strike Groups

Pop. Group	Mgmt. Group	Strike Category	Obs. Sample	Sample Used in Analysis	Ave.Wkly. Ridership Overall Mean	Std.Err. Overall Mean	Ave.Wkly Ridership Analysis Mean	Std.Err. Analysis Mean
40,000-360,000	Private	Strike	12	12	105,830	20,340	105,830	20,340
	Private	Nonstrike	33	12	31,860	7,650	21,430	6,800
	Public	Strike	8	8	44,700	13,080	44,700	13,080
	Public	Nonstrike	56	12	44,560	6,240	55,740	9,600
360,001-1,499,999	Private	Strike	3	8	1,248,250	227,410	1,248,250	74,440
	Private	Nonstrike	14	14	276,330	78,270	276,330	78,270
	Public	Strike	9	9	342,640	105,470	342,640	342,640
	Public	Nonstrike	9	9	224,220	63,020	224,220	63,020
1,500,000 & Greater	Private	Strike	4	10	1,377,900	501,320	1,377,900	183,060
	Private	Nonstrike	1	9	1,038,000	---	1,038,000	0
	Public	Strike	7	9	2,792,790	935,010	2,792,790	714,130
	Public	Nonstrike	5	10	2,580,930	1,882,270	2,580,930	969,660

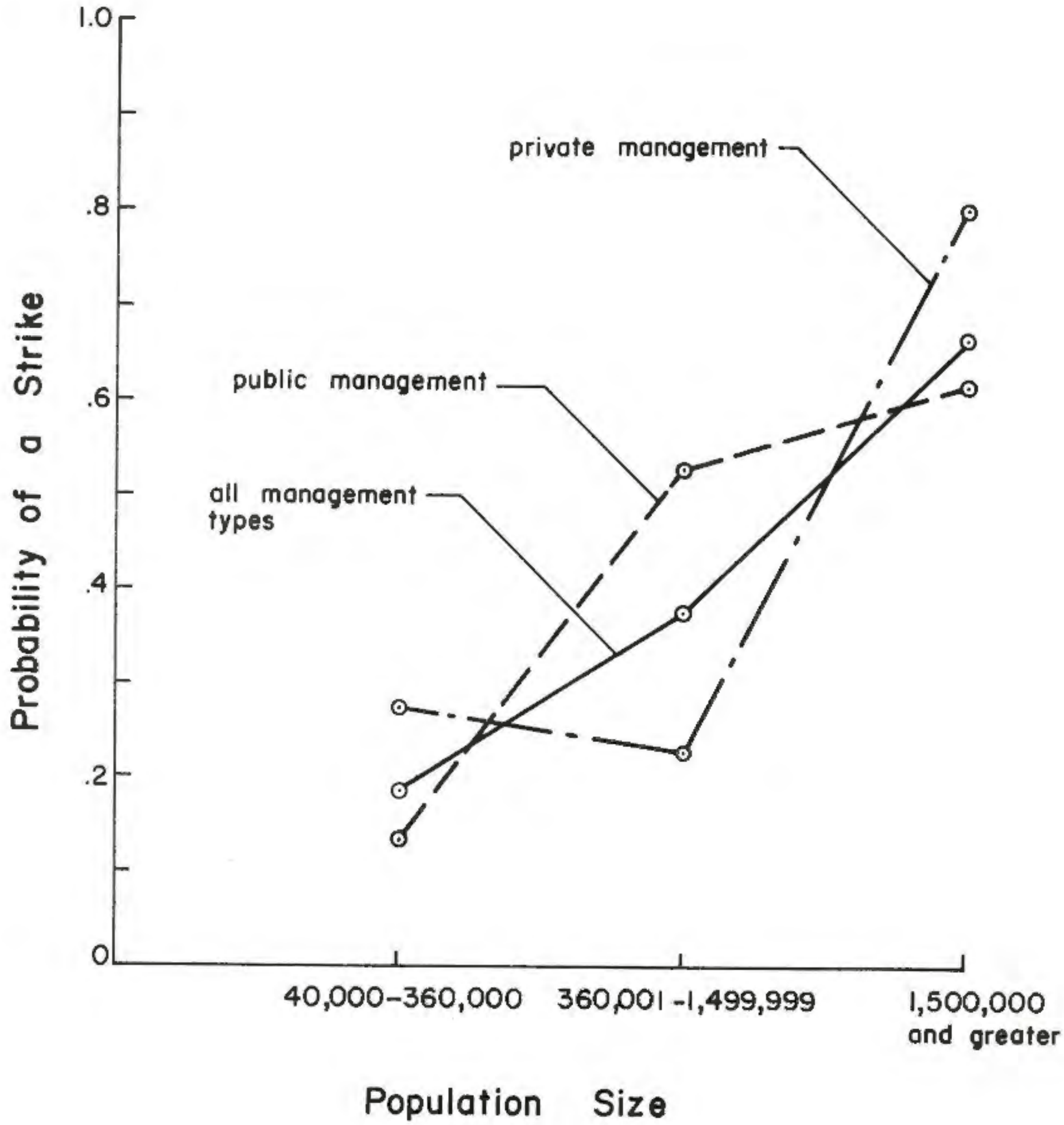

FIGURE 5.1, INFLUENCE OF SERVICE AREA POPULATION SIZE AND MANAGEMENT TYPE ON STRIKE POTENTIAL (January, 1961 – June, 1976)

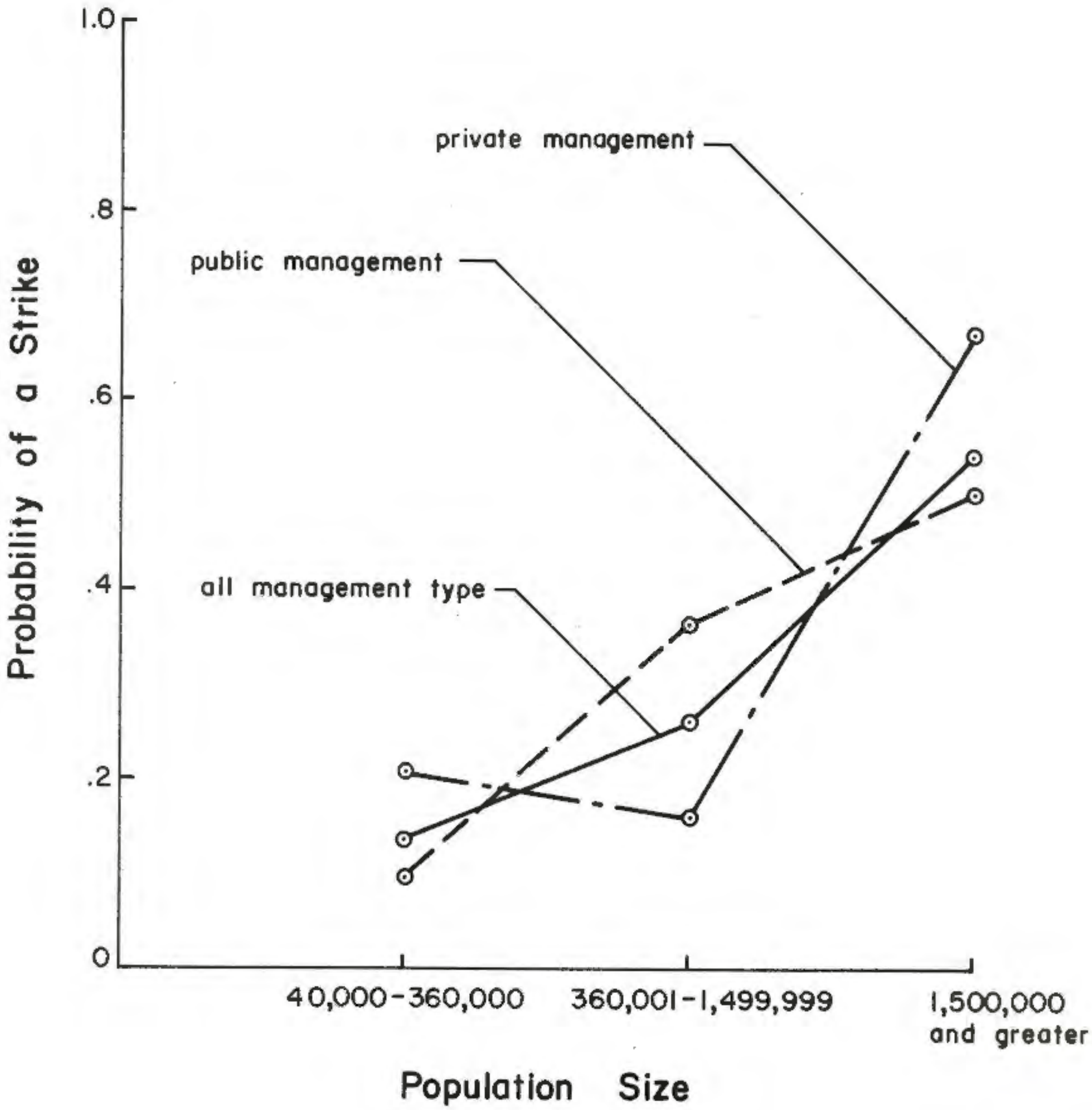

FIGURE 5.2, INFLUENCE OF SERVICE AREA POPULATION SIZE AND MANAGEMENT TYPE ON STRIKE POTENTIAL
(January, 1971 - June, 1976)

transformed for use in the analysis. A three-way Model B ANOVA was used; the results are illustrated in Table 5.11.

As can be seen, service area population size, and the occurrence of a strike, are strongly related to current weekly ridership. Management type comes into consideration through the two-way interactions. These correlations were investigated using the Duncan-Bonnor multiple range test. This test confirmed that as service area population size increases, current weekly ridership also increases.

Additionally, there does appear a significant ridership size difference between those systems struck in the last fifteen years, and those not struck. Nonstruck properties tend to be the smallest in their respective population groups, struck properties the largest. This fact supports the previous conclusion that larger systems suffer greater strike probabilities.

Information obtained from the ANOVA also indicates that management type, and the management-population size interaction influences, to some degree, the relationship between ridership and strike potential.

Relationship Between Service Area Population Size, Management Type, The Number of Strikes in 15 Years, and the Most Recent Strike Duration

Two additional factors of interest would be population and management relationship to the number of strikes in 15 years, and the most recent strike duration. In Tables 5.12 and 5.13 are presented listings of information summarized from the questionnaire which will be used in this analysis.

Two Model B ANOVAs were constructed to test relationships among the above variables. These are illustrated in Tables 5.14 and 5.15. The analysis was performed only over those systems that had been struck at least once during the last 15 years.

Table 5.11. ANOVA B Results - Current Average Weekly Ridership by Population Size, Management Type, and Strike Occurrence

	Degrees of Freedom	Mean Square	Calculated F	Significance of F
Service Area Population Size	2	103.360	83.450	.001*
Management Type	1	.193	.156	.999
Strike Dccurrence	1	27.566	22.256	.001*
Population-Management Interaction	2	3.818	3.083	.048*
Population-Strike Interaction	2	.781	.631	.999
Management-Strike Interaction	1	6.972	5.629	.018*
Residual	110	1.239		

* Significant at α = .1.

Table 5.12. Number of Strikes in 15 Years for Various Population and Management Groups

Population	Management	Sample Size	# Strikes/15 Yrs.
40,000-360,000	Private	11	1.82
	Public	8	2.00
360,001-1,499,999	Private	4	1.75
	Public	8	2.50
1,500,000 and Greater	Private	4	2.50
	Public	8	2.63

Table 5.13. Duration (Days) of the Most Recent Strike for Various Population and Management Groups

Population	Management	Sample Size	Average Strike Duration (Days)	Standard Error
40,000-360,000	Private	12	34.8	9.7
	Public	7	53.3	37.4
360,001-1,499,999	Private	4	48.0	22.0
	Public	8	23.9	8.5
1,500,DDO and Greater	Private	4	35.5	12.0
	Public	8	18.6	7.5

Tables 5.14 and 5.15 indicate that the number of strikes in the past 15 years, for a particular system, have not been influenced by service area population size or management type. This might appear to contradict the previous conclusion that strike probability increases with system size, however it must be remembered that the present analysis considers only those systems which were struck at least once, while the previous analysis considered all systems, including both struck and nonstruck ones. Upon reviewing the raw data, shown in Figure 5.3, it can be seen that the great majority of systems have reported only one strike in the last fifteen years.

Thus it can be concluded that, while the probability for an urban bus transit system to experience a strike increases with an increase in system size, the probability of having more than one strike <u>does not</u> vary with changes in system size. In all cases management type has no effect on either strike probability, or the number of strikes suffered by the system.

When reviewing these conclusions one should note that survey returns have indicated a majority of the most recent strikes (68.8%) have occurred within the last five years. Additionally, of those systems which have had only one strike from 1961-1976, 59.1% (13 out of 22) have occurred since 1971.

Since most systems have experienced a strike so recently, and for many of them it was their first strike, the above findings appear to indicate that management and labor may not wish to instigate a second strike so soon. This reluctance would explain why the number of strikes experienced by a system is not subject to size or management type, and tends to indicate that it is more strongly dependent on the time interval between strikes.

Table 5.14. ANOVA B Results - Number of Strikes/15 Years by Population Size, and Management Type

	Degrees of Freedom	Mean Square	Calculated F	Significance of F
Service Area Population Size	2	.143	.642	.999
Management Type	1	.009	.041	.999
Population-Management Interaction	2	.027	.120	.999
Residual	37	.223		

Table 5.15. ANOVA B Results - Most Recent Strike Duration by Population Size, and Management Type

	Degrees of Freedom	Mean Square	Calculated F	Significance of F
Service Area Population Size	2	.382	.171	.999
Management Type	1	5.744	2.575	.113
Population-Management Interaction	2	.021	.009	.999
Residual	37	2.231		

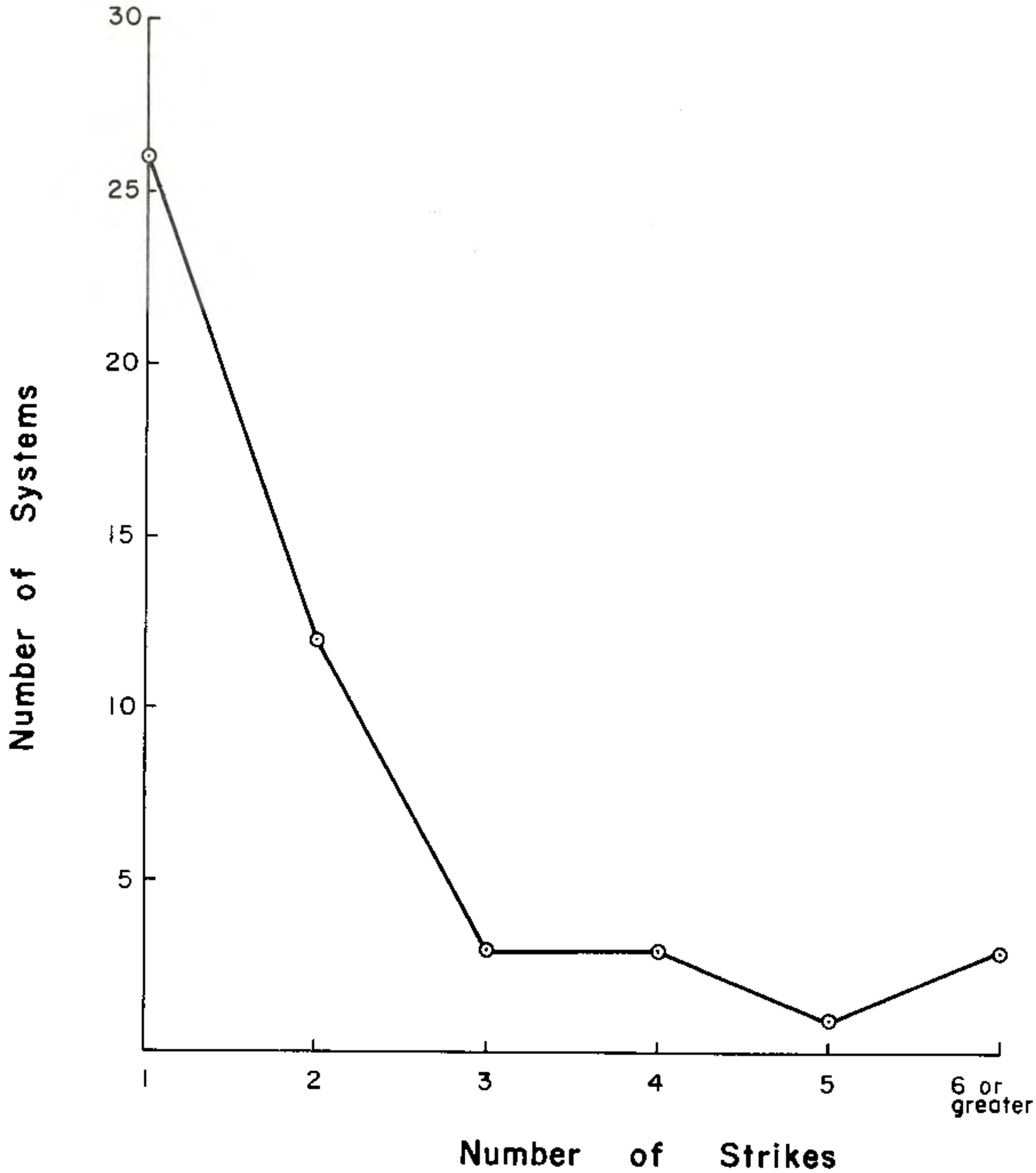

FIGURE 5.3, NUMBER OF STRIKES EXPERIENCED BY SYSTEMS
(January, 1961 – June, 1976)

Upon examining Table 5.15, system size and management type are observed to have little correlation with strike duration. A Chi-Square test was run to further investigate this relationship. A calculated X^2 of 18.252 (with df=3, significance = .250) reinforced the conclusion that any duration effect is spread evenly among all population and management groups. Once a strike is initiated, its length is independent of these two factors.

In this connection review should be made of a survey conducted by the American Public Transit Association (APTA) which was distributed to all transit systems in North America during December, 1974. While similar to the present study in its investigation of public transportation work stoppages, the APTA survey was more oriented toward labor issues which might have instigated the strike action. Tables 5.16 and 5.17 are two summary tables containing responses to the APTA questionnaire.

As can be seen, 15.1% of those U.S. systems which replied suffered some sort of work stoppage in 1974. While this is lower than the 28.1% strike rate for properties which had responded to the study questionnaire, it must be remembered that in the latter case transit shutdowns were monitored over a 15 year period, in the former only over a 1 year period (1974).

Mean strike duration from the APTA survey was found to be 31 days for U.S. properties. It is interesting to note that this figure agrees closely with the study mean strike duration, calculated as 34.1 days.

Trend of Strike Incidence

When reviewing strike frequencies during the study period, it is of interest to determine whether the number of strikes per year has significantly increased, decreased, or remained the same with the passage of time. In order to

Table 5.16. Summary of Transit Industry Work Stoppages During 1974 (a)

	Affecting Canadian Systems	Affecting U.S. Systems	Total
Number of Systems Affected by Official Strikes	5	9	14
Number of Official Strikes	5	9	14
Average Duration of Official Strikes Ending in 1974	43 days	31 days	35 days
Number of Official Strikes Settled by Negotiation	0	3	3
Number of Official Strikes Settled by Arbitration	1	0	1
Number of Official Strikes Settled by Mediation	1	1	2
Number of Official Strikes Settled by Conciliation	3	1	4
Number of Official Strikes Settled by Other Means	0	2	2
Number of Official Strikes in Progress on Dec. 31, 1974	0	2	2
Number of Systems Affected by Unofficial Work Stoppages	1	9	10
Number of Unofficial Work Stoppages	5	10	15
Average Duration of Unofficial Work Stoppages	11 days	2 days	5 days

(a) Data for transit systems responding to APTA survey only.

Source: American Public Transit Association, "Summary Report, 1974 Transit Industry Work Stoppages," Washington, D. C., 1975. (Mimeographed).

Table 5.17. Summary of Responses to APTA Work Stoppage Questionnaire for Calendar Year 1974

	Systems Reporting No Official Strikes or Unofficial Work Stoppages	Systems Reporting Official Strikes	Systems Reporting Unofficial Work Stoppages	Systems Reporting Both Official Strikes and Unofficial Work Stoppages	Total Systems Reporting
Canadian Systems	5	5	0	1	11
U.S. Systems	95	9	8	0	112
Total Systems Reporting	100	14	8	1	123

Source: American Public Transit Association, "Summary Report, 1974 Transit Industry Work Stoppages," Washington, D. C., 1975. (Mimeographed).

pursue this investigation with the data at hand, the following assumptions were made:

a) The number of systems included in the survey have existed from 1961-1976. This is a reasonable assumption because, while the ownership status and management type may change, the overall number of organizations offering public transportation can be expected to remain the same.

b) The number of strikes has been reported accurately over the entire study period by each responding system.

Since only the date of the most recent strike has been obtained, questionnaire results may be biased by tending to indicate a greater proportion of strikes in the last few years than is actually the case. To correct for this all systems with more than two reported strikes were eliminated from the analysis. Additionally, of those systems which had suffered two transit shutdowns, the data points were selected in preparation for one way ANOVA examination. Table 5.18 illustrates both the reported number of strikes, and those selected for analysis. Data was grouped into three-year time periods to facilitate analysis.

The results of one way ANOVA are illustrated in Table 5.19.

From the above Table, the Duncan-Bonnor Multiple Range Test, and the testing of contrasts, it can be concluded that strike incidence has increased in recent years. Specifically, the number of strikes per 3 year interval from 1970-1975 were significantly greater than during 1967-1969; and the number of strikes per 3 year interval from 1967-1969 were significantly greater than from 1961-1966.

Table 5.18. Industrywide Strike Incidence (January, 1961-June, 1976)

Years	Reported Number of Strikes	Number of Strikes Selected for Analysis
1961-1963	1	1
1964-1966	1	1
1967-1969	8	6
1970-1972	10	9
1973-1975	20	11
January-June, 1976*	3	--
Total	43	28

*Excluded from analysis.

Table 5.19. Oneway ANOVA - Number of Strikes by Time

	Degrees of Freedom	Mean Square	Calculated F	Significance of F
Between Groups	4	6.933	4.333	.027*
Within Groups	10	1.600		

*Significant at $\alpha = .1$.

With the advent of the 1964 Urban Mass Transportation Act and subsequent legislations at Federal, state, and local levels, greatly increased financial assistance was made available to the transit systems for capital investment and operating expenditures. This substantial increase in the amount of funding offered to transit properties may have inadvertently created stronger labor expectations for higher salaries and greater benefits. However, because most of these subsidies were for capital improvements, these desires could not be met by management. This appears to have been one of the contributing factors for this apparent increase in union activity, reflected in significantly higher strike counts during 1970-1975 than 1967-1969, and higher counts during 1967-1969 than 1961-1966.

Strike Impact on Average Adult Fare

Tables 5.20 and 5.21 illustrate change of fare for various population and management groups immediately after the strike, and one year after the reporting date. A Model A ANOVA was run on these two variables, the results are shown in Tables 5.22 and 5.23.

As can be seen, at the $\alpha = .1$ level there is a significant increase in average adult fare both immediately after the strike, and one year after the reporting date. This immediate change is due only to the strike, while one year after the reporting date there is also a population (and thus system size) effect. Using the Duncan-Bonnor multiple range test, and contrast techniques, it appears that the medium and larger systems had statistically similar fare increases, while the smaller systems had the lowest fare increase. In no case did management type influence these results. Chapter 4 discussed "natural" time trends in the transit industry. At that time it was observed that the industry-wide fare increase expected in

Table 5.20. Change in Fare Immediately After a Strike for Various Population and Management Groups

Population	Management	Sample Size	Immediate Change in Fare (%)
40,000-360,000	Private	5	+ .86
	Public	2	-8.33
360,001-1,499,999	Private	4	+7.98
	Public	6	+8.33
1,500,000 and Greater	Private	3	+23.33
	Public	7	+4.44

Table 5.21. Year Change in Fare for Various Population and Management Groups

Population	Management	Sample Size	Year Change in Fare (%)
40,000-360,000	Private	2	+ .29
	Public	2	- 8.33
360,001-1,499,999	Private	3	+30.85
	Public	3	+17.78
1,500,000 and Greater	Private	3	+23.33
	Public	6	+18.37

Table 5.22. ANOVA A Results - Immediate Change in Average Adult Fare by Service Area Population Size, Management Type, and Strike Occurrence

	Degrees of Freedom	Mean Square	Calculated F	Table F (α = .1)
Service Area Population Size	2	64.011	.12	2.58
Management Type	1	451.402	.83	2.96
Population-Management Interaction	2	875.379	1.61	2.58
Companies	21	544.51		
δ (error term)	0			
Time (strike occurrence)	1	30.285	4.67	2.96*
Population-Time Interaction	2	12.944	2.00	2.58
Management-Time Interaction	1	7.027	1.08	2.96
Population-Management-Time Interaction	2	7.324	1.13	2.58
Companies-Time Interaction	21	6.48		
ε (error term)	0			

*Significant at α = .1.

Table 5.23. ANOVA A Results - Year Change in Average Adult Fare by Service Area Population Size, Management Type, and Strike Occurrence

	Degrees of Freedom	Mean Square	Calculated F	Table F $(\alpha = .1)$
Service Area Population Size	2	2313.343	.79	2.72
Management Type	1	3391.639	1.15	3.14
Population-Management Interaction	2	3878.951	1.32	2.72
Companies	13	2942.770		
δ (error term)	0			
Time (strike occurrence)	1	113.384	13.18	3.14*
Population-Time Interaction	2	27.672	3.22	2.72*
Management-Time Interaction	1	.246	.03	3.14
Population-Management-Time Interaction	2	2.011	.23	2.72
Companies-Time Interaction	13	8.600		
ε (error term)	0			

*Significant at $\alpha = .1$.

one year is 3.76%. Because of the difficulty in isolating a control group, this figure contains both struck and non-struck systems (see Table 4.2). This number is less than that recorded immediately after the strike (+6.32%), and one year after the reporting date (+16.32%). Thus, even considering the average industry-wide fare increase, there is still a strike impact.

This fare change can be expected in a situation where a highly labor-favorable contract settlement was achieved, and even with increased subsidies enough financial resources could not be acquired to meet the larger manpower costs.

Since the next section shows that a cutback in service does not result from a strike, and increased government subsidies can only be conjectured, it appears that increased operating costs are absorbed through higher fares. (It should be mentioned here that a non-strike negotiated contract may have the same effect on operating costs as a labor-management agreement resulting from a strike. The strike situation may serve merely as justification for a fare increase which would have become necessary anyway).

A fare increase would be expected to involve managerial assessment of system financial position, and other bureaucratic procedures. Thus it is anticipated that a greater proportion of the fare increases would occur over the long term. This is precisely what happens, reflected in the higher overall fare change one year after the reporting date.

Strike Impact on Service: Vehicle-Hours of Operation, Miles of Route, Service Index

Strike impact on bus service to the transportation consumer was measured in three ways: changes in vehicle-hours of operation, changes in one-way system miles of route, and changes in the service index. As defined, the

service variable indicates the level of service offered to transit patrons. A numerical increase or decrease may indicate such changes as greater or lesser headways between vehicles on the routes, or a reduction or gain in the average number of buses in service during the day. The variable is defined as follows:

$$ISERVICE = \frac{ICHNGHRS}{(1-ICHNGMIL)}$$

$$YSERVICE = \frac{YCHNGHRS}{(1-YCHNGMIL)}$$

Tables 5.24-5.29 illustrate changes in vehicle-hours of operation, system miles of route, and service indices for various population and management groups immediately after the strike, and one year after the reporting date. A model A ANOVA was run on vehicle-hours of operation. Due to the nature of available data a model B ANOVA was required for analyzing miles of route and the service index. These are illustrated in Tables 5.30-5.35.

Upon reviewing the preceding ANOVA results the following observations were made:

a) As can be expected vehicle-hours of operation varied among population groups, however no impact of a strike can be detected on these changes. Since the analysis also indicated that immediate change in vehicle-hours of operation was not significant at α = .25, one can be fairly confident that it does not change because of a work stoppage. Because α = .25 at one year was significant it can only be noted that year change in vehicle-hours of operation was not influenced by a strike occurrence.

b) By excluding abnormal information from one respondent, it can be concluded that total system

Table 5.24. Immediate Change in Average Weekly Vehicle-Hours of Operation for Various Population and Management Groups

Population	Management	Sample Size	Immediate Change in Veh.-Hrs.(%)
40,000-360,000	Private	4	-10.66
	Public	2	-28.12
360,001-1,499,999	Private	3	+ 3.73
	Public	5	-23.87
1,500,000 and Greater	Private	3	-18.10
	Public	2	- .05

Table 5.25. Year Change in Average Weekly Vehicle-Hours of Operation for Various Population and Management Groups

Population	Management	Sample Size	Year Change in Veh.-Hrs. (%)
40,000-360,000	Private	3	- 4.93
	Public	2	-17.59
360,001-1,499,999	Private	3	+ 0.39
	Public	3	- 3.96
1,500,000 and Greater	Private	2	- 6.00
	Public	3	- 2.58

Table 5.26. Immediate Change in System Miles of Route for Various Population and Management Groups

Population	Management	Sample Size	Immediate Change in Miles of Route (%)
40,000-360,000	Private	4	0.00
	Public	2	-16.67
360,001-1,499,999	Private	3	+ 6.62
	Public	6	- 4.05
1,500,000 and Greater	Private	3	0.00
	Public	6	- .18

Table 5.27. Year Change in System Miles of Route for Various Population and Management Groups

Population	Management	Sample Size	Year Change in Miles of Route (%)
40,000-360,000	Private	3	+5.09
	Public	2	-5.23
360,001-1,499,999	Private	3	+8.64
	Public	4	-2.21
1,500,000 and Greater	Private	2	0.00
	Public	5	+ .51

Table 5.28. Immediate Change in Service Index for Various Population and Management Groups

Population	Management	Sample Size	Immediate Change in Service Index (%)
40,000-360,000	Private	4	- .106
	Public	2	- .422
360,001-1,499,999	Private	3	+ .034
	Public	5	- .250
1,500,000 and Greater	Private	3	- .182
	Public	2	- .001

Table 5.29. Year Change in Service Index for Various Population and Management Groups

Population	Management	Sample Size	Year Change in Service Index (%)
40,000-360,000	Private	3	- .052
	Public	2	- .214
360,001-1,499,999	Private	3	.007
	Public	3	- .041
1,500,000 and Greater	Private	2	- .060
	Public	3	- .029

Table 5.30. ANOVA A Results - Immediate Change in Average Weekly Vehicle-Hours of Operation by Service Area Population Size, Management Type, and Strike Occurrence

	Degrees of Freedom	Mean Square	Calculated F	Table F (α = .1)
Service Area Population Size	2	1.265×10^{10}	14.38	2.63*
Management	1	3.701×10^{6}	.004	3.01
Population-Management Interaction	2	3.318×10^{8}	.38	2.63
Companies	18	8.795×10^{8}		
δ (error term)	0			
Time (strike occurrence)	1	1.777×10^{8}	1.06	3.01
Population-Time Interaction	2	1.067×10^{8}	.64	2.63
Management-Time Interaction	1	1.026×10^{8}	.61	3.01
Population-Management-Time Interaction	2	1.131×10^{8}	.67	2.63
Companies-Time Interaction	18	1.677×10^{8}		
ϵ (error term)	0			

*Significant at α = .1.

Table 5.31. ANOVA A Results - Year Change in Average Weekly Vehicle-Hours of Operation by Service Area Population Size, Management Type, and Strike Occurrence

	Degrees of Freedom	Mean Square	Calculated F	Table F (α = .1)
Service Area Population Size	2	2.898×10^{10}	2.61	2.74
Management Type	1	1.423×10^{8}	.13	3.11
Population-Management Interaction	2	3.181×10^{8}	.29	2.74
Companies	14	1.109×10^{9}		
δ (error term)	0			
Time (strike occurrence)	1	2.482×10^{6}	1.57	3.11
Population-Time Interaction	2	1.044×10^{6}	.66	2.74
Management-Time Interaction	1	9.622×10^{5}	.61	3.11
Population-Management-Time Interaction	2	6.568×10^{5}	.42	2.74
Companies-Time Interaction	14	1.580×10^{6}		
ϵ (error term)	0			

Table 5.32. ANOVA B Results - Immediate Change in System Miles of Route by Service Area Population Size and Management Type

	Degrees of Freedom	Mean Square	Calculated F	Significance of F
Service Area Population Size	2	13174.916	1.809	.191
Management Type	1	36146.641	4.964	.037*
Population-Management Interaction	2	11820.041	1.623	.224
Residual	18	7282.357		

Table 5.33. ANOVA B Results - Year Change in System Miles of Route by Service Area Population Size and Management Type

	Degrees of Freedom	Mean Square	Calculated F	Significance of F
Service Area Population Size	2	1021.797	.130	.999
Management Type	1	21075.283	2.689	.122
Population-Management Interaction	2	5963.580	.761	.999
Residual	13	7837.554		

*Significant at $\alpha = .1$.

Table 5.34. ANOVA B Results - Immediate Change in Service Index by Service Area Population Size and Management Type

	Degrees of Freedom	Mean Square	Calculated F	Significance of F
Service Area Population Size	2	.143	.958	.999
Management Type	1	.362	2.422	.141
Population-Management Interaction	2	.299	1.996	.174
Residual	13	.150		

Table 5.35. ANOVA B Results - Year Change in Service Index by Service Area Population Size and Management Type

	Degrees of Freedom	Mean Square	Calculated F	Significance of F
Service Area Population Size	2	.907	2.084	.174
Management Type	1	1.185	2.724	.127
Population-Management Interaction	2	.487	1.119	.366
Residual	10	.435		

miles of route is not influenced by a work stoppage immediately after the strike or one year after the reporting date.

c) As discussed at the beginning of this section, the service variable indicates the level of service offered to transit patrons. A numerical increase or decrease may indicate such changes as greater or lesser headways between vehicles on the routes, or a reduction or gain in the average number of buses in service during the day. No significant change in this index due to a strike situation could be detected from this analysis technique.

At this point it is worth mentioning that when independent variable data is grouped to accommodate a particular statistical method, important differences within the group may be overlooked. In the last section regression predictive equations were run to interpret significant post-strike ridership decreases which were detected. In this case service changes, in the form of the service index, were found to explain significantly part of this patronage decline.

Results are interpreted in the following way; it can be expected that management would attempt to hold bus availability steady while reviewing its post-strike contractural commitments. If a service reduction was deemed in order, it would be easier to alter the number of vehicles on the road (through retrenchment in the number of drivers, or other means) than to employ the planning resources necessary to change economically and efficiently the route structure. Both these procedures would require a longer implementation time than could be detected immediately after a strike, or even one year after the reporting date.

An additional factor worth mentioning is the increasing number of private transit properties reorganized as public systems in recent years, as discussed in Chapter 2. This greatly increases the occurrence of government subsidy to ailing members of the industry. As the supply of public transportation is considered an important service, increased subsidies are desired in place of service cutbacks. This may explain the lack of significant service reductions due to a strike.

Strike Impact on Average Daily Ridership

Tables 5.36 and 5.37 illustrate change in average daily ridership for various population and management groups immediately after the strike, and one year after the reporting date. A Model A ANOVA was run on these two variables, and the results are shown in Tables 5.38 and 5.39.

The results shown in Table 5.38 indicate that there is a significant decrease in ridership observed immediately after a strike; ranging from -8.7% to -25.8% for various population and management groups. Additionally, the extent of the ridership decrease varies with population size, but not with management type.

One year after the reporting date Table 5.39 indicates that again the service interruption caused a significant patronage decrease which averaged -4.3%. However at this time the ridership decline did not vary with population or management type.

On the basis of the ANOVA tests, and upon examination of the original data, it can be stated that a significant number of patrons are diverted from transit usage in large numbers immediately after a strike. However, one year after the reporting date it appears that a system recovers many of its lost users, either through the return of former passengers or the generation of new ones.

Table 5.36. Immediate Change in Average Daily Ridership for Various Population and Management Groups

Population	Management	Sample Size	Immediate Change in Ridership (%)
40,000-360,000	Private	4	-25.77
	Public	3	-20.85
360,001-1,499,999	Private	3	-12.22
	Public	4	-19.24
1,500,000 and Greater	Private	2	- 8.70
	Public	2	-19.29

Table 5.37. Year Change in Average Daily Ridership for Various Population and Management Groups

Population	Management	Sample Size	Year Change in Ridership (%)
40,000-360,000	Private	3	- 4.72
	Public	2	- 4.04
360,001-1,499,999	Private	3	- 5.47
	Public	3	+ 5.05
1,500,000 and Greater	Private	1	-11.66
	Public	3	- 9.83

Table 5.38. ANOVA A Results - Immediate Change in Average Daily Ridership by Service Area Population Size and Management Type

	Degrees of Freedom	Mean Square	Calculated F	Table F (α = .1)
Service Area Population Size	2	8.078×10^{11}	2.95	2.77*
Management Type	1	2.714×10^{11}	.99	3.14
Population-Management Interaction	2	2.078×10^{11}	.76	2.77
Companies	13	2.734×10^{11}		
δ (error term)	0			
Time (strike occurrence)	1	3.967×10^{9}	4.98	3.14*
Population-Time Interaction	2	4.769×10^{9}	5.98	2.77*
Management-Time Interaction	1	1.531×10^{9}	1.92	3.14
Population-Management-Time Interaction	2	2.215×10^{9}	2.78	2.77*
Companies-Time Interaction	13	7.971×10^{8}		
ε (error term)	0			

*Significant at α = .1.

Table 5.39. ANOVA A Results - Year Change in Average Daily Ridership by Service Area Population Size and Management Type

	Degrees of Freedom	Mean Square	Calculated F	Table F (α = .1)
Service Area Population Size	2	6.927×10^{11}	2.37	2.86
Management Type	1	2.553×10^{11}	.88	3.23
Population-Management Interaction	2	1.202×10^{11}	.41	2.86
Companies	11	2.918×10^{11}		
δ (error term)	0			
Time (strike occurrence)	1	1.200×10^{11}	3.23	3.23*
Population-Time Interaction	2	5.673×10^{9}	1.48	2.86
Management-Time Interaction	1	2.005×10^{9}	.52	3.23
Population-Management-Time Interaction	2	1.413×10^{9}	.37	2.86
Companies-Time Interaction	11	3.841×10^{9}		
ϵ (error term)	0			

*Significant at α = .1.

In Chapter 4 "natural" time trends in the transit industry were reviewed. At that time it was observed that the industry-wide ridership decline expected in one year is 2.09% of system patronage. Because of the difficulty in isolating a control group, this figure contains both struck and nonstruck systems (see Table 4.2). This number is less than that recorded one year after the reporting date (3.32% of system patronage). Thus it appears that even with the recovery of many of its lost users, there is still a strike impact over the "long" term.

The problem identified here is that the above figures show systems in stagnation and/or decline. Within the past few years there has been a resurgence in public transportation, particularly with increased capital investment and good marketing practices. The potential ridership increase attributable to these actions, and which was lost because of the strike, are reflected in the strong post-strike patronage declines shown in Tables 5.36 and 5.37.

Detection of significant changes in transit patronage has been the overriding goal of this study. So far, no significant changes in system service variables have been found, except in average adult fare. Consequently, it can be expected that the observed ridership decline was caused either directly by the observed fare increase, or by a combination of several factors affecting bus transit patronage. A different approach, using regression analysis, was used to interpret these significant decreases. The discussion on the regression approach is presented later in this chapter.

Strike Impact on Market Index

Tables 5.40 and 5.41 illustrate changes in the market index for various population and management groups immediately after the strike, and one year after the

Table 5.40. Immediate Change in Market Index for Various Population and Management Groups

Population	Management	Sample Size	Immediate Change in Market (%)
40,000-360,000	Private	4	-2.19
	Public	3	- .45
360,001-1,499,999	Private	3	-4.81
	Public	4	-3.24
1,500,000 and Greater	Private	2	- .89
	Public	2	-7.73

Table 5.41. Year Change in Market Index for Various Population and Management Groups

Population	Management	Sample Size	Year Change in Market (%)
40,000-360,000	Private	3	- .46
	Public	2	- .08
360,001-1,499,999	Private	3	-2.64
	Public	3	-5.06
1,500,000 and Greater	Private	1	-1.33
	Public	3	-8.20

reporting date. A model A ANOVA was run on these two variables. The results are shown in Tables 5.42 and 5.43.

As defined, the market variable is a derived index which normalizes transit ridership according to the service area of a system. As a per capita ridership measure, it gives an indication of the impact a strike may have on the transit market by reflecting proportional changes in ridership. It is defined as follows:

$$\text{IMARKET} = \frac{\text{BBUSAVEV-IABUSAVV}}{\text{POPULATN}} * 100$$

$$\text{YMARKET} = \frac{\text{BBUSAVEV-YABUSAVV}}{\text{POPULATN}} * 100$$

On the basis of the above analysis, and further investigation at $\alpha = .25$, it can be said with fairly high confidence that immediately after a work stoppage the decrease in ridership is proportionally the same for all urban areas. This indicates that immediate strike effect on ridership will be the same for both large and small systems.

One year after the reporting date a significant impact differential is detected among larger and smaller properties. Since the previous section revealed that the system patronage decrease one year later was less than that immediately after the work stoppage, it appears that system recovery varies according to system size. Empirically reviewing Tables 5.36 and 5.37 leads one to believe that smaller systems recover their lost passengers faster than larger ones. This is supported by research which has indicated that the smaller the urban area population size, the greater the proportion of captive riders in relation to choice riders.[4] It seems that because a smaller system carries more captive riders, they will return to the system sooner than will pre-strike choice riders. The ramification of this will be discussed in the conclusions.

Table 5.42. ANOVA A Results - Immediate Change in Market Index by Service Area Population Size, Management Type, and Strike Occurrence

	Degrees of Freedom	Mean Square	Calculated F	Table F (α = .1)
Service Area Population Size	2	.231	1.37	2.77
Management Type	1	.082	.49	3.14
Population-Management Interaction	2	.214	1.27	2.77
Companies	13	.169		
δ (error term)	0			
Time (strike occurrence)	1	.000	.01	3.14
Population-Time Interaction	2	.008	.80	2.77
Management-Time Interaction	1	.005	.50	3.14
Population-Management-Time Interaction	2	.003	.30	2.77
Companies-Time Interaction	13	.010		
ϵ (error term)	0			

Table 5.43. ANOVA A Results - Year Change in Market Index by Service Area Population Size, Management Type, and Strike Occurrence

	Degrees of Freedom	Mean Square	Calculated F	Table F (α = .1)
Service Area Population Size	2	.332	2.27	2.86
Management Type	1	.080	.55	3.23
Population-Management Interaction	2	.073	.50	2.86
Companies	11	.146		
δ (error term)	0			
Time (strike occurrence)	1	.007	3.50	3.23*
Population-Time Interaction	2	.003	1.25	2.86
Management-Time Interaction	1	.001	.50	3.23
Population-Management-Time Interaction	2	.001	.25	2.86
Companies-Time Interaction	11	.002		
ε (error term)	0			

*Significant at α = .1.

Regression Analysis of System Post-Strike Ridership Decline

In an effort to further investigate and predict the relationship between transit ridership changes and a strike situation, a regression analysis was performed. In this section the MARKET index has been defined as the dependent variable, all others as independent. The variables used in this analysis are illustrated in Table 5.44.

A stepwise regression analysis was performed. This method involves entering variable based on their contribution to the equation. That variable with the largest individual F statistic is entered first. The order of insertion of the remaining variables is determined by using a partial F value. At each step those variables already entered into the equation are re-examined to determine if they should remain. Any variable which provides a nonsignificant contribution to the regression equation, based on its partial F-value, is removed. This process is continued until no variables can be entered or removed.

Additionally variables were checked for collinearity (using correlation coefficients) and their individual significance to the equation (using the F-test). Based on the above, two equations were developed. These are described below.

A) Long Term Per Capita Change in Ridership

$$YMARKET = -1.7332 + .6580 \times 10^{-5} (POPULATN) + 76.4542(YSERVICE) - 40.3494(ISERVICE)$$

R^2 = .850

Significance = .007

Sample Size = 10

Table 5.44. Regression Variables

Dependent	Independent
A) Immediate Change in Market Index	Service Area Population Size, Management Type, Strike Duration, Immediate Fare Change, Immediate Change in Service Index.
B) Year Change in Market Index	Service Area Population Size, Management Type, Strike Duration, Immediate Fare Change, Year Fare Change, Immediate Change in Service Index, Year Change in Service Index.

where

YMARKET = long term per capita change in ridership =

$$\frac{BBUSAVEV-YABUSAVV}{POPULATN} * 100$$

POPULATN = service area population size
Standard Error = $.2393 \times 10^{-5}$

YSERVICE = long term service change = $\frac{YCHNGHRS}{(1-YCHNGMIL)}$

Standard Error = 17.9015

ISERVICE = short term service change = $\frac{ICHNGHRS}{(1-ICHNGMIL)}$

Standard Error = 10.1905

CONSTANT TERM : Standard Error = 2.2681

The above equation suggests that as service area population increases, the proportion of riders who returned to the system after one year decreases. This corresponds with the ANOVA analysis discussed earlier. Additionally, it should be noted that a long term service increase results in a per capita ridership increase, again as expected.

The short term service index (ISERVICE) was included in this analysis to make the long term per capita ridership estimate more sensitive to immediate post-strike service changes which had occurred. It was observed that this variable significantly contributed to the amount of patronage decline explained by the regression. The above equation shows that if service is increased one year after the reporting date, it increases the long term per capita ridership recovery. However if service is increased

immediately after the strike it serves to reduce the long term recovery of the system. Although this contradiction can be expected from the purely empirical nature of the model an explanation can be offered, and is discussed below.

A service improvement immediately after a strike might not create as favorable an impact (due to immediate antagonism toward the system by pre-strike patrons) as an improvement at a later date (when potential users might be more receptive, and respond more favorably). Thus an immediate post-strike increase in service would not gain as many passengers over the long term as would a service improvement at a later time (one year after the reporting date) because there would be few new incentives for patrons at the later date. In any case, it should be noted that the influence of immediate service changes on ridership one year after the reporting date is only about half that of year service changes.

Below are illustrated two additional equations which were derived, the first without the ISERVICE variable, the second without the YSERVICE variable. As can be seen, neither equation predicts as well as the first, and neither is significant.

1) $$\text{YMARKET} = -.8604 + .7691 \times 10^{-5}\ (\text{POPULATN}) + 52.7437\ (\text{YSERVICE}) - .0838\ (\text{DURATION})$$

R^2 = .595

Significance = .121
Sample Size = 10

where

YMARKET = as defined previously

POPULATN = as defined previously
Standard Error = $.3953 \times 10^{-5}$

YSERVICE = as defined previously
Standard Error = 30.7218

DURATION = strike duration in days

Standard Error = .05871

CONSTANT TERM : Standard Error = 4.1423

2) $YMARKET = -5.9804 + .6167 \times 10^{-5} (POPULATN)$

$+ 4.3410 (TMANAGE) - 6.5787 (ISERVICE)$

$R^2 = .445$

Significance = .284

Sample Size = 10

where

YMARKET = as defined previously

POPULATN = as defined previously

Standard Error = $.5477 \times 10^{-5}$

TMANAGE = a "dummy" variable representing management type. 0 = public systems; 1 = private systems

Standard Error = 5.7716

ISERVICE = as defined previously

Standard Error = 11.1120

CONSTANT TERM : Standard Error = 7.1056

Upon examining the above two equations, it should also be noted that when ISERVICE is not included, DURATION enters the equation. However, while its contribution to the overall R^2 value is good (.138), its standard error is much too high, and therefore it can be considered non-significant. When YSERVICE is not included, management type enters the equation. Again its standard error is too high, additionally both management and ISERVICE do not greatly contribute to the overall R^2 (.023 and .032 respectively). Thus these two equations are both inferior to the first.

B) Short Term Per Capita Change in Ridership

$$IMARKET = 3.1427 - 7.6259\ (ICHNGFAR) - .3366 \times 10^{-6}\ (POPULATN) + 1.1962\ (ISERVICE)$$

R^2 = .094

Significance = .793

Sample Size = 14

where

IMARKET = short term per capita change in ridership =

$$\frac{BBUSAVEV-IABUSAVV}{POPULATN} * 100$$

POPULATN = service area population size

Standard Error = $.6475 \times 10^{-6}$

ISERVICE = short term service change = $\frac{ICHNGHRS}{(1-ICHNGMIL)}$

Standard Error = 3.3403

ICHNGFAR = short term fare change = $\frac{BBUSFARE-IABUSFAR}{BBUSFARE}$

Standard Error = 8.7361

CONSTANT TERM : Standard Error = 1.4846

Because of the extremely low significance and R^2 of this equation, its worth can be considered extremely small. In comparing the two equations, it can be seen that prediction of immediate changes in patronage levels is much more difficult than prediction one year after the reporting date. This is to be expected, as the long-term reaction of pre-strike transit patrons is probably more stable, and thus more easily explained, than their immediate reaction. Additionally, it was found that the date system ridership was measured immediately after a strike varied more among respondents than the one year reporting date. Undoubtedly

the more stable one year measure greatly improved long-term predictive ability.

A year after the reporting date ridership decline appears influenced by service area population size (correlating quite highly with the findings from the previous section) and service changes. The fact that changes in service, and not in fare (which did significantly increase because of a strike) best explain long-term patronage decline is in line with the Kemp study discussed in Chapter 1. Kemp concluded that while transit demand is sensitive to changes in fare, it is instead significantly more sensitive to changes in the level of service.[7]

Notes

1. Simpson and Curtin, "Special Report-Fares," Metropolitan Transport cited in Barnum, Collective Bargaining in Urban Transit, p. 30.

2. Kemp, "Some Evidence of Transit Demand Elasticities."

3. Norman H. Nie et al., Statistical Package for the Social Sciences, 2nd ed. (New York: McGraw-Hill Book Company, 1975), p. 383.

4. As each variable was defined negative indicates increase, positive a decrease. To follow normal sign convention (negative indicates decrease and positive indicates increase) signs were reversed for tabular presentation.

5. While short term varied management was not significant when private, this was actually due to the small number of data points at the highest population level.

6. B. G. Hutchinson, Principles of Urban Transport Systems Planning, (Washington, D.C.: Scripta Book Company, 1974), p. 69.

7. Kemp, "Some Evidence of Transit Demand Elasticities," p. 25.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

Strike Impact on Captive Patrons

A strike-induced transit shutdown does exert a significant influence on in-strike travel patterns and post-strike ridership trends. From the case studies discussed in Chapter 3, and the questionnaire analysis, it becomes apparent that those people most heavily affected by a strike are transit "captives" such as the elderly, the young, the poor, and the handicapped. It has been found that when deprived of their means of travel many of them must suppress their trips. The following three examples illustrate this.

During the 1974 Alameda-Contra Costa Transit Strike there was a suppression rate of 50-60% for the elderly and the young, almost twice the average trip suppression rate for AC transit users.[1] Only about 4% of the San Bernardino Express Bus choice riders curtailed their trips during the 1974 Southern California Rapid Transit Strike, compared to 17% of the elderly (over 65 years) regular transit users.[2] And during the 1966 New York City Transit Strike, while 15% of the middle-income workers ($3,000-$9,000 annual income) stayed home during the entire strike, this figure was 30% for low-income (under $3,000) respondents.[3]

There are some transit users with only marginal captivity, meaning that they are able to make temporary arrangements during a strike. However a high percentage of the captive riders are unable to do so, and must

eliminate or make fewer shopping, medical, work, and other trips during the strike period. As was noted in the questionnaire analysis and Chapter 3 case studies many of these people do return to the bus system after the strike, but that is essentially because they have no other long-range alternative means of travel.

Need for Choice Riders

In about the last 35 years transit patronage and revenues have been on the decline, with properties operating at an industry-wide loss since about 1963. This has caused an extremely tenuous financial position for many privately owned transit properties, resulting in an increasing number of bankruptcies for them. As discussed in Chapter 2, since most transit organizations maintain a virtual monopoly within a certain area, and because they provide such an important public service, local governments have attempted to salvage these systems with the creation of publicly owned organizations to replace them. This management transition has resulted in a large influx of local, state, and Federal financial assistance to these companies. Unfortunately, even with this help, the steady patronage loss has only recently been halted, and certainly not markedly reversed. In order for transit companies to break out of this stagnation it has become obvious that they must capture a larger share of the "choice" and marginally captive user market. Choice patrons are those which use public transportation not because it is the only mode available to them, but because they believe it presents certain advantages over other competing modes which they could utilize (e.g. an automobile which they own). Marginally captive riders include those who are temporarily captive. However, if discouraged from further transit patronage they may purchase a car, carpool with friends, or take a taxi.

Renewed capital investment, special fares and programs, and other better marketing practices all contribute to the continuing effort for transit revitalization. Unfortunately it appears that after a strike "choice" patrons and marginally captive riders which transit company management is trying so hard to capture are driven away, and return much slower than pre-strike captives. This is where a strike frustrates management efforts to broaden its market. Choice and marginally captive riders want good reliable service. Every service interruption only diverts these patrons back to alternate modes, requiring the company to lure them back again.

The Role of Management

As discussed in Chapter 2, the transit industry is a highly labor intensive field, with the cost of manpower typically representing 60%-80% of all operating costs. Thus highly labor-favorable contract settlements, and an absence of increased government subsidy or other additional financial resources needed to meet the larger manpower costs, would most certainly result in higher post-strike fares as one of the only viable solutions, next to service reductions. In fact the questionnaire analysis did find fare to increase significantly following a strike. However it was also found that fare increases did not explain long term ridership trends. Rather changes in service, measured in terms of route structure modification and variations in vehicle hours of operation, was the best predictor of this long term patronage recovery.

The main thrust of the argument is this: what initially diverts people away from post-strike bus use is the service interruption itself, which forces them to seek alternative modes of travel. What keeps them away a year after the reporting date could be permanent adjustment to their new travel pattern.

It appears that the most important task of management is to prevent users from seeking alternate forms of travel. A service interruption is the major factor which diverts transit patrons, especially among choice users. Thus a strike should be avoided whenever possible. In the past management and labor have used various techniques in attempting to resolve contract disputes before they reach a strike situation. These have included compulsory arbitration, seizure laws, voluntary binding arbitration, compulsory binding arbitration, fact finding and mediation. Some have proved more effective than others. With the increasing number of systems converting to public management, the above bargaining techniques are becoming increasingly more popular. Darold T. Barnum notes:

> The right to strike is, in most cases, illegal for public system employees, a situation in direct contrast to that found in private transit negotiations. Moreover, the strike weapon has been replaced by compulsory binding arbitration in some cases and by unilateral determination by management in others. The visible result to date has been a sharp increase in the number of transit arbitrations.[4]

The point is that at present public transportation is in a tenuous situation. Due to a delicate demand market, service interruptions can only serve to aggravate an already deteriorating situation. Management and labor have the tools available to limit the number of disputes which lead to a strike situation. These should be implemented on as wide a scale as possible, in order to spare present and potential users the disruption caused by a temporary cessation of public transportation services.

This study has also shown that service changes have a more damaging effect on long-term patronage than a fare increase. Thus if a contract settlement does force management to either seek additional sources of revenue, or institute

service cutbacks, fares should be raised instead of decreasing service. These questions are especially critical in larger systems, where it has been found that the probability of a strike occurrence is greatest, irrespective of management type.

In order for management to continue its revitalization of the industry, the reliable service that patrons desire must be maintained. This can only be achieved by the prevention of work stoppages, and by greater cooperation in the settlement of labor disputes. A strengthening of the industry will ultimately benefit all parties concerned - labor, management, and consumers as well.

Recommendations for Future Research

Research needs in this field are enormous. In order to quantify more effectively strike effects, a greatly expanded data base is required. Ideally complete case histories of several transit properties would be needed in order to account for company trends and the many other variables involved.

Additionally, to expedite questionnaire returns only the most recent system strike has been considered in this study. It would be useful to determine the impact of multiple strikes on a transit property in order to judge system response with greater accuracy.

For all intents and purposes this study has been the first nation-wide analysis of transit strike impacts. The findings of this report should prove useful to both transportation planners and transit management. Hopefully it will assist in the provision of safe, reliable public transportation to all transit patrons.

Notes

1. Stephen G. Cohn and Raymond H. Ellis, Impacts of the AC Transit Strike Upon BART, p. X.

2. J. L. Crain and S. D. Flynn, SCRTD Strike, p. 11, 13.

3. Barrington and Company, Effect of 1966 New York City Transit Strike, p. 3.

4. Darold T. Barnum, Collective Bargaining and Manpower in Urban Transit, p. 230.

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APPENDIX

PURDUE UNIVERSITY
SCHOOL OF CIVIL ENGINEERING
WEST LAFAYETTE, INDIANA 47907

January 16, 1976

Dear Sir:

The School of Civil Engineering and the Department of Industrial Administration of Purdue University are conducting a research project entitled "The Effect of Strikes on Urban Mass Transit Use". Funded by the U. S. Urban Mass Transportation Administration, it is directed by Professor Kumares C. Sinha of the School of Civil Engineering and Professor Michael W. Pustay of the School of Industrial Administration.

The purpose of this study is primarily to provide insight into the post-strike ridership decline problem, and to yield information regarding the travel behavior of transit riders during a transit strike.

As part of this study we need input from transit systems across the nation.

We would deeply appreciate it if you would kindly complete and return this questionnaire as soon as possible. A self-addressed stamped envelope is enclosed for your convenience.

We will be happy to forward to you a copy of the research report when it is completed.

Thank you for your kind assistance.

Sincerely,

Mitchell Brachman

Mitchell Brachman
Graduate Assistant in Research
Department of Transportation
School of Civil Engineering
Purdue University

MB:sas

Enclosure

1) What is the population of the area you serve? ________

2) Could you please give a brief description of the area you serve (eg. political subdivisions such as counties, municipalities, etc.)?

____

____

____

3) What is the average weekly ridership of your system?

____

4) What kind of management runs the transit system?

a) private company
b) local government with own personnel
c) autonomous authority with own personnel
d) contract management
e) other ______________________

5) Within the last fifteen years has your transit system been affected by a labor strike, or work slowdown, from any of your employee groups (operators, clerical help, maintenance men, etc.) and did this strike or slowdown result in a curtailment or reduction in service provided by your system?

YES _____ NO _____

Please complete the remainder of this questionnaire <u>only if you answered YES to the above question</u>.

6) How many times has your system been struck in the past fifteen years? _______

WHEN ANSWERING THE QUESTIONS BELOW, PLEASE CONSIDER THE MOST RECENT STRIKE IF MORE THAN ONE HAS OCCURED.

7) On what date did the strike begin?

_______ _______ _______
(day) (month) (year)

8) What was the duration of the strike? _______
(days)

9) Before the Strike: (Please use data collected as close before the start of the strike as possible.)

a) What was the average adult transit fare charged by your system?

____

b) What was the total length of routes served by your system?

__________ miles

c) What were your total vehicle-hours of operation per week?

____

d) What was the transit ridership during:

	Volume	Hours of the Day
Morning peak	________	_____ - _____
Off peak	________	_____ - _____
Evening peak	________	_____ - _____

e) What is the most recent date prior to the strike that any of the above data (questions 9a-9d) was collected?

REPORTING DATE: _____ (day) _____ (month) _____ (year)

10) After the Strike

a) What was the average adult transit fare charged by your system?

Immediately after the end of the strike ______
(Approx. date data was collected ______)

One year after the reporting date of question 9(e) ______
(Approx. date data was collected ______)

b) What was the total length of routes run by your system?

Immediately after the end of the strike ______
(Approx. date data was collected ______)

One year after the reporting date of question 9(e) ______
(Approx. date data was collected ______)

c) What were the total vehicle-hours of operation per week for:

Immediately after the end of the strike ________
(Approx. date data was collected ________)

One year after the reporting date of question 9(e) ________
(Approx. date data was collected ________)

d) What was the transit ridership immediately after the end of the strike?

	Volume	Hours of the Day
Morning peak	________	______ - ______
Off peak	________	______ - ______
Evening peak	________	______ - ______

(Approx. date data was collected ________)

One year after the reporting date of question 9(e)

	Volume	Hours of the Day
Morning peak	________	______ - ______
Off peak	________	______ - ______
Evening peak	________	______ - ______

(Approx. date data was collected ________)

THANK YOU