PASSENGER UTILIZATION OF LOCAL VS EXPRESS TRAINS FOR A NEW YORK CITY SUBWAY LINE: A CASE STUDY

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A survey of over 5000 passengers on the IRT #1 line was conducted in New York City in order to examine passenger attitudes, perceptions and, most importantly, travel mode preferences (local vs express). Passengers were asked whether they prefer faster or more comfortable trains. It was found that they were evenly divided in their preference between faster trains and more comfortable ones, regardless of the distance travelled. However, it was found that significant numbers of passengers opted to transfer to crowded express trains, with little or no savings in travel time, while parallel local trains ran much less crowded. Passengers were asked to estimate their travel time and the results were compared to measured travel times. Passengers consistently overestimated their travel time and correlated their use of express trains with faster service. A major conclusion of this study is that the overall quality of service on the #1 line may be improved by inducing passengers to stay on local trains when travelling even moderate distances. This will promote a better passenger load distribution between the local and express and provide all passengers with a more comfortable level of service with no significant increase in travel time.

The operational effectiveness of mass transit systems is strongly dependent on the attitudes and preferences of the system users. In our study we examine attitudes, perceptions, and most importantly, travel mode and preferences for a sample of riders on one New York City subway line.

The subway system of New York City consists of a diverse network of interconnecting lines. In many parts of the network, local tracks run parallel with express tracks, providing the passenger with two travel modes. For example, the IRT #1 line, which starts at 242nd Street and Broadway, joins the #2 line and #3 express line at 96th Street. The local and express tracks run parallel down to Chambers Street in lower Manhattan. Figure 1 shows a map depicting the express and local stations involved in our study.

During the morning rush period, the local trains frequently have empty seats at 96th Street, whereas the express trains are most often extremely crowded. Many passengers who board the local trains at the uptown stations transfer to the express at 96th Street. Since this transfer appears to involve a sacrifice of travel comfort, it seems to be motivated by the passenger's desire to decrease the overall travel time (defined as the time from boarding at the station of origin to arriving at the station of destination).

It has been observed that many passengers choose to transfer at 96th Street to the express, henceforth referred to as "local/express" travel mode or simply "express" mode, rather than continue on the local train ("local" mode). There is a visible imbalance in the passenger loads carried by the local trains versus the express trains departing the 96th Street station, downtown. One of our goals was to examine whether passengers indeed correlated the express mode with faster service and, if so, whether the transfer to express trains was justified in terms of the gains in speed, in view of the resulting discomfort.

We have surveyed over 5000 passengers boarding the #1 IRT line at uptown 157th through 103rd Street stations. In addition, we have measured the actual travel times from any of the uptown stations to the downtown stations shown in express stops in Figure 1. Measured travel-times were obtained for both the local and local/express travel modes. Twelve independent timed runs, made during the morning rush period in April 1977, form the basis for the travel-time matrix. By comparing the passenger's travel mode preferences with the data in the measured travel-time matrix, we are able to evaluate how effectively the subway passengers are utilizing the travel mode option that is available to them. Based on this analysis, recommendations are made to affect improvements in the passenger utilization of the system.

The level of service provided by the subway system is dependent on both the speed of transport and the level of comfort provided to passengers. We investigated subway user attitudes concerning their preference for speed versus comfort and in particular correlated this preference with their choice of travel mode. Since the overall level of comfort is not readily quantifiable, we related

"comfort" merely to the observed passenger loads and the availability of seats. No attempt was made to measure these variables, but it was observed that passenger loads on local trains were significantly and visibly lower than on express trains.

Our study provides the basis for:

1. An evaluation of the effectiveness of the passenger utilization of the local vs local/express travel modes.
2. An evaluation of subway user perceptions concerning overall travel time.
3. An evaluation of passenger preference for speed vs level of comfort and a correlation of their preference with their choice of travel mode.
4. Recommendations for improving the overall level of service on the studied line by effecting improvements in the passenger's choice of travel mode.

The above evaluations and recommendations are presented below.

Survey Method

Passenger Interviews

The passenger survey was conducted during the morning rush hours (7:00 a.m. - 9:30 a.m.) during five consecutive weekdays in April 1977. Passengers boarding the downtown IRT #1 trains at the survey stations (indicated in Figure 1) were asked five questions:

1. Do you regularly travel from this station?
2. What is your final destination station (any one of the stations in Figure 1 or "other")?
3. Will you transfer to the express train at 96th Street?
4. Do you prefer faster service or more comfortable service?
5. Estimate the travel-time in minutes from the time that you leave here to the time that your train arrives at your destination station.

Passengers were interviewed in turnstile areas of the stations by students of the City College of New York wearing identification badges. The responses of over 6000 interviewed passengers were recorded and carefully screened for errors, ambiguities and inconsistencies. As a result, about 750 (12.5%) of the responses were rejected and not used in the analysis.

Survey Population. We restricted the survey to rush hours since most subway travel takes place in commuting to and from work. Eighty-eight percent of the passengers interviewed were regular commuters. A survey during rush hours may show a bias towards speed preference, but since rush hours are the most critical in designing, scheduling and improving service, it is felt that no significant error would result in our conclusions. In a recent survey of travel modes in New York City (1), it was found that 80% of those who commute to work use public transportation, with a subway to bus ratio of 3:1, i.e., 60% of all commuters travel by subway to work. For travel other than work, the comparable figure is about 16%. These numbers show that the primary use of the subway is indeed in commuting to and from work, and this use far exceeds all other uses combined.

Technical Aspects of the Survey. One objective of our survey was to study the feasibility and the logistics involved in a systemwide origin-destination survey of New York subway riders. Our limited study illuminated some of the difficulties involved, like ambiguities in survey questions, language difficulties in areas with high percentages of Hispanics and even hostility toward pollsters.

Most past surveys of transit users have been based on extensive home questionnaires. On-site interviews have limitations on scope and depth, but provide a fast and cost/effective method of collecting data. Such surveys have been used to obtain simple preference data in the past. See, for example, Zell's study of bus riders in the San Francisco Bay area (2).

Data Analysis. Rigorous statistical analysis of variance was carried out for the measured travel time matrix to find the effects of station of origin, station of destination and travel mode on the travel times. The analysis showed that there is a statistically significant difference between travel time via the local/express mode as compared to the local mode. However, the effect due to the travel mode was found to be much smaller than the effect due to either the station of origin or the station of destination.

The data compiled for the passenger survey included statistics on:

a . Local vs local/express use.
b . Speed vs comfort preference.
c . Correlation of "a" and "b".
d . Speed-comfort preference vs distance travelled.
e . Choice of travel mode vs distance travelled.
f . The number of passengers travelling from origin to destination.
g . The percentage of "f" who use express or local trains.
h . The percentage of "f" who prefer speed vs comfort.
i . The mean estimated travel time from origin to destination.
j . The standard deviation of "i".

Results and Conclusions

Travel Time Analysis

Table 1 shows the mean travel-times measured from every station of origin to every station of destination obtained from twelve independent measurements. Also included in Table 1 are the mean passenger estimates of their travel-times. The standard deviations of the measured travel times are in all cases less than 10% of the tabulated means. The standard deviations of all the passenger travel-time estimates are in all cases less than 25% of the tabulated means.

From Table 1, it is evident that the travel times using the "local" mode are competitive with the travel times using the "express" mode for all stations of origin and stations of destination down to and including 34th Street. At 34th Street, the difference between the mean travel time (averaged over all stations of origin) for the "local" vs "express" modes is two minutes. This 11% difference is not judged significant. Although only express stops are included in the list of destinations, it is obvious that for any

Figure 1. Map of Studied Subway Line

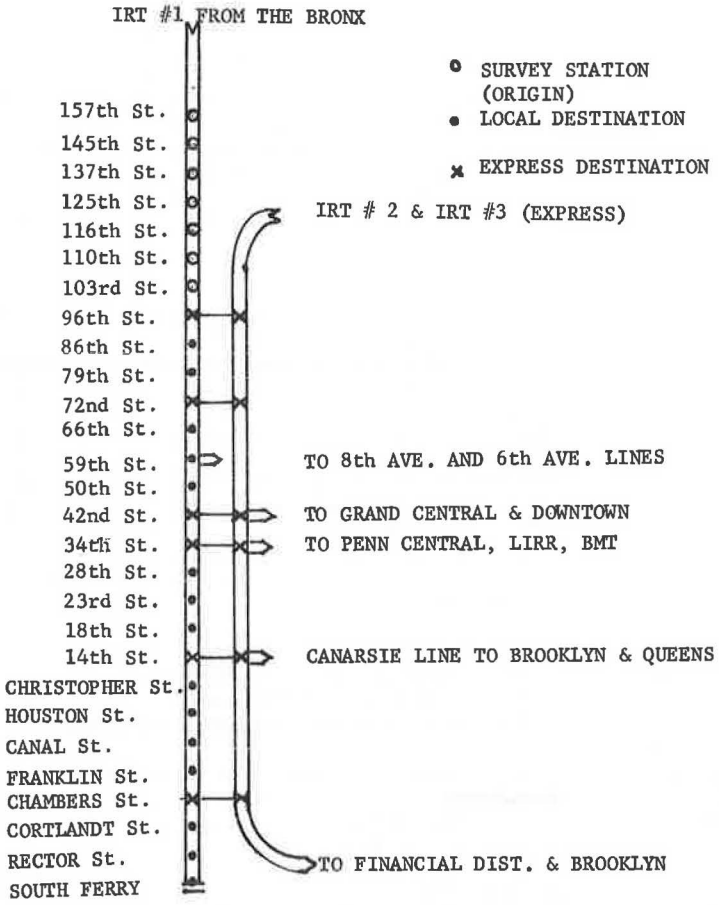

Table 1. Measured and Passenger Estimated Travel-Time (Minutes).

DESTINATION	72 St.			42 St.			34 St.			14 St.			Chambers St.		
ORIGIN	Est.	Loc.	Exp.	Est.	Loc.	Exp.	Est.	Loc.	Exp.	Est.	Loc.	Exp.	Est.	Loc.	Exp.
157 St.	20.3	17.8	18.3	29.2	23.8	22.6	31.0	26.7	24.6	34.8	31.1	27.1	41.6	37.6	31.0
145 St.	18.3	15.8	16.5	24.3	21.8	20.9	27.1	24.7	23.0	31.8	28.9	25.3	38.4	35.6	29.2
137 St.	22.0	13.8	14.1	24.1	19.9	18.5	27.0	22.6	20.4	36.0	27.1	22.9	37.7	33.5	26.8
125 St.	14.5	11.1	11.9	22.3	17.3	16.2	24.2	20.0	18.2	31.5	24.4	20.7	33.4	30.9	24.5
116 St.	15.0	8.4	9.0	19.2	14.5	13.4	20.4	17.1	15.3	27.3	21.7	17.8	27.4	27.9	21.7
110 St.	11.9	7.2	7.2	18.1	13.4	11.5	20.0	15.7	13.5	24.0	20.7	16.0	30.7	27.1	19.9
103 St.	10.8	6.0	6.0	16.3	12.1	10.3	18.3	14.6	12.3	21.4	19.4	14.8	27.3	25.9	18.7
Mean:	16.1	11.5	11.9	21.9	17.8	16.2	24.0	20.2	18.2	29.5	24.8	20.7	33.8	31.2	24.5

Est = Overall Passenger Estimate, Loc = Measured in Local Mode,
Exp = Measured in Local/Express Mode.

Table 2. Passenger Estimated Travel Times for Local Mode Passengers Vs. Local/Express Passengers (In Minutes)

Destination		Origin						
	Mode	157 St.	145 St.	137 St.	125 St.	116 St.	110 St.	103 St.
72 St.	Local	20.5	20.0*	20.0*	13.2*	-	11.3*	-
	Express	20.0*	17.3	30.0*	15.7*	15.0*	12.5*	10.8*
42 St.	Local	27.3	24.6	24.2	22.9	21.2	19.0	15.8
	Express	29.7	23.7	24.2	22.1	18.8	17.8	16.4
34 St.	Local	30.6	27.1	26.6	24.8	19.4	17.7	17.1
	Express	31.2	27.1	27.2	23.9	20.6	21.0	18.8
14 St.	Local	31.2	32.8	32.6*	31.0	26.5	21.0	21.7*
	Express	36.0	31.6	36.8	31.7	27.5	24.4	21.3
Chambers	Local	31.2*	39.3	49.7*	30.0*	-	41.2	26.0*
	Express	42.5	38.2	36.5	33.6	27.4	29.3	27.7

Note: Numbers marked * are based on small samples of less than five responses.

local destinations above 34th Street, the local mode would be preferable to the local/express mode because of the need for a second transfer. At the 14th Street and Chambers Street destinations, the local/express travel mode is faster than the local mode by 4.1 and 6.7 minutes respectively. These are judged to represent a significant reduction in overall travel time (i.e., 16.5% and 21.5% reductions).

A major conclusion from Table 1 is that the transfer to the express train may be justified (from the viewpoint of overall travel time) when the destination is either 14th Street or further. We have excluded stations of destination in Brooklyn, lower Manhattan (below Chambers Street) and Queens from our analysis where it may indeed be sensible to choose the local/express mode.

From Table 1, it also is evident that passengers consistently overestimate their overall travel-time by roughly 10% to 20%. This suggests that they perceive the system as offering a lower level of service than it actually provides, with respect to travel-time. Table 2 compares estimated travel times of passengers in the local mode vs passengers in the local/express mode. The table shows that the estimates obtained by the two groups do not show any significant difference. In particular, express users do not have lower estimates of their travel time although the measured times in express mode are somewhat lower as shown in Table 1. This evidence suggests that those passengers who choose the express mode are more pessimistic in their time estimate than those using local mode. Perhaps their choice of mode is affected by this pessimism.

The results of Tables 1 and 2 are displayed graphically in Figures 2 and 3 for travel originating at one typical station.

Travel Mode and Service Preferences. Table 3 presents contingency tables relating the choice of travel mode (local vs express) to the service preferences of passengers (speed vs comfort). The tables show that regardless of the type of destination (local stop or express stop) the choice of mode is not independent of the service preference, based on X^2 tests at 0.01 level of significance. All three tables show a positive correlation between express mode and speed preference. Further analysis of Tables 3b and 3c shows that the type of destination (local or express) has an effect on service preferences: passengers to local destinations show a higher preference for comfort than do passengers to express destinations. This seems to confirm the fact that passengers who are more likely to use the local train become aware of the greater level of comfort that it affords.

These conclusions also are supported by the numbers in Table 4. Figure 4, on the other hand, shows that the speed or comfort preferences did not change significantly with the distance travelled. Roughly half the passengers surveyed prefer speed and half prefer comfort, independent of the distance travelled. In contrast, the choice of travel mode is strongly affected both by type of destination and by distance. There is a significantly higher use of the express mode to express destinations (Table 4), and the choice of express increases with the distance as shown in Figure 5.

Conclusions. While most of the results above are not surprising, our analysis demonstrates that many passengers erroneously correlate the express mode with higher speed and as a result are misusing the system. A striking example is that 46.4% of the passengers to 72nd Street transfer to the express even though the overall travel time in this mode is slightly longer than with the "local" mode. Seventy-seven percent of the passengers to 42nd Street chose the express to gain an average of 1.5 minutes. We conclude that the severe imbalance in passenger loads between local and express trains leaving 96th Street is not justified and that many passengers who transfer to the express are doing disservice to themselves as well as to others.

Recommendations

Since the major cause for the imbalance in passenger loads arises from misconceptions held by the public about the relative speed of express and local trains, the forthright approach to remedy the situation would be to educate and inform the public. This is usually easier said than done. A step in the right direction has already been taken on some lines by posting and distributing subway timetables showing travel times to all destinations along the line.

Passengers might be induced to stay in the local train if the practice of waiting for the local at 96th Street were stopped. Under this practice, express trains wait in the station for the next local train, so that local passengers can transfer without waiting on the ramp. The net result is further delay of the express and an inducement to transfer from the local into the crowded express train.

Finally, if the above measures fail, rescheduling of express trains might be considered, along with possible changes in routing. For example, it seems that the express stop at 72nd Street could be eliminated without adversely affecting many passengers.

Acknowledgments

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References

1. D. L. Weiss and E. P. Donelly. "Characteristics of New York State Transit Users". New York State Department of Transportation, August 1976.
2. C. E. Zell. San Francisco-Oakland Bay-Bridge Trans-Bay Bus Riders Survey. Highway Research Record No. 114, 1966, pp. 169-182.

Figure 2. Measured and Estimated Travel Times From 145th Street to Destination.

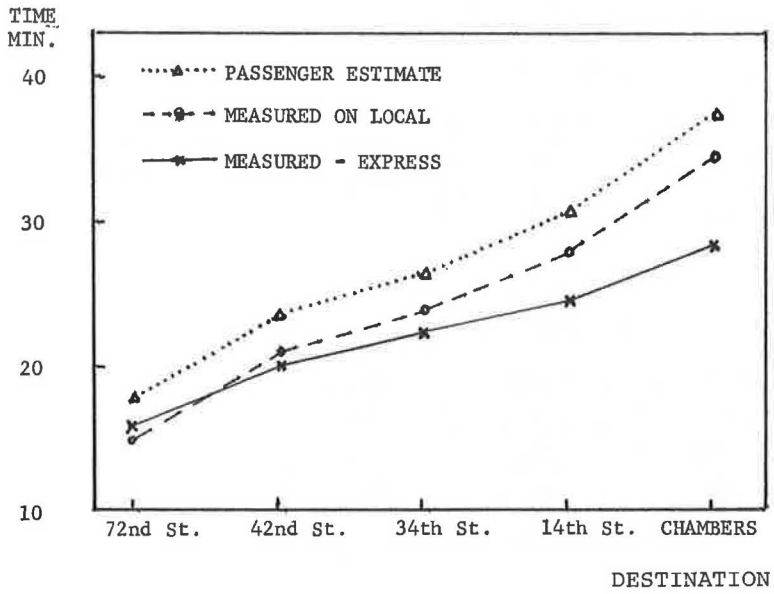

Figure 3. Passenger Estimates of Travel Times From 145th Street to Destination

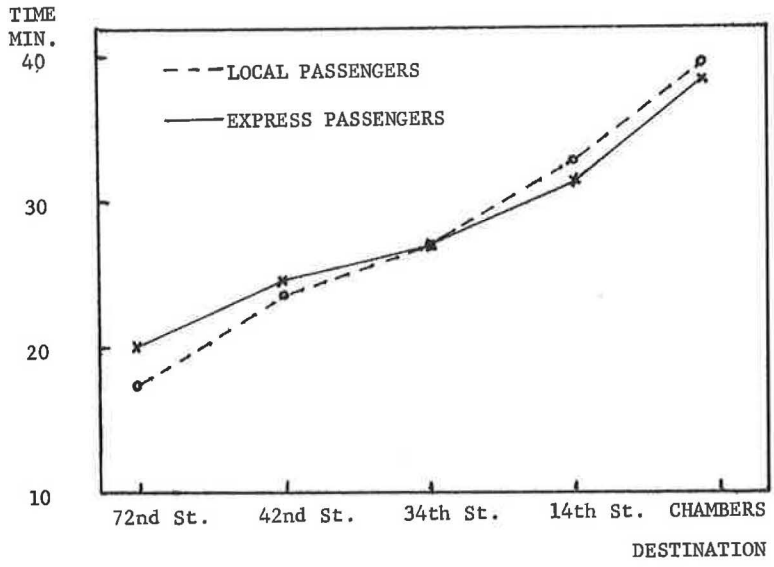

Table 3. Cross Tabulation of Mode of Travel and Passenger Service Preferences

A. Number of Responses for all Passengers:

Mode/Preference	Speed	Comfort	Total	%	
Express	1595	1336	2931	55%	
Local	970	1433	2403	45%	X^2 = 104.4
Total	2565	2769	5334		
%	48%	52%			

B. Number of Responses for Passengers with "Express" Destinations.

Mode/Preference	Speed	Comfort	Total	%	
Express	762	648	1410	76%	
Local	148	293	441	24%	X^2 = 56.3
Total	910	941	1851		
%	49%	51%			

C. Number of Responses for Passengers with "Local" Destinations Below 72nd Street.

Mode/Preference	Speed	Comfort	Total	%	
Express	188	148	336	22%	
Local	480	681	1161	78%	X^2 = 22.5
Total	668	829	1497		
%	45%	55%			

Table 4. Mode of Travel and Service Preferences by Destination

		Mode		Preference	
Destination	Total Number	Local %	Express %	Comfort %	Speed %
All Local Above 72 Street	518	92.1	7.9*	54.4	45.6
Local Between 42 Street and 72 Street	923	93.2	6.8	55.4	44.6
Local Between 14 Street and 42 Street	406	54.9	45.1	55.7	44.3
Local Below 14 Street	168	46.4	53.6	54.8	45.2
72 Street	47	53.2	46.8	63.8	36.2
42 Street	1003	23.0	77.0	51.5	48.5
34 Street	405	30.9	69.1	49.1	50.9
14 Street	215	19.1	80.9	47.0	53.0
Chambers St.	181	10.5	89.5	51.9	48.1
All Others (Below Chambers or on Other Lines)	1468	22.1	77.9	48.8	51.2
Total	5334	45.1%	54.9%	51.9%	48.1%

*Note: These responses were inconsistent, since the local/express mode is not possible above 72 Street.

Figure 4. Percent of Passengers Preferring Speed Over Comfort as a Function of Distance to Their Destinations.

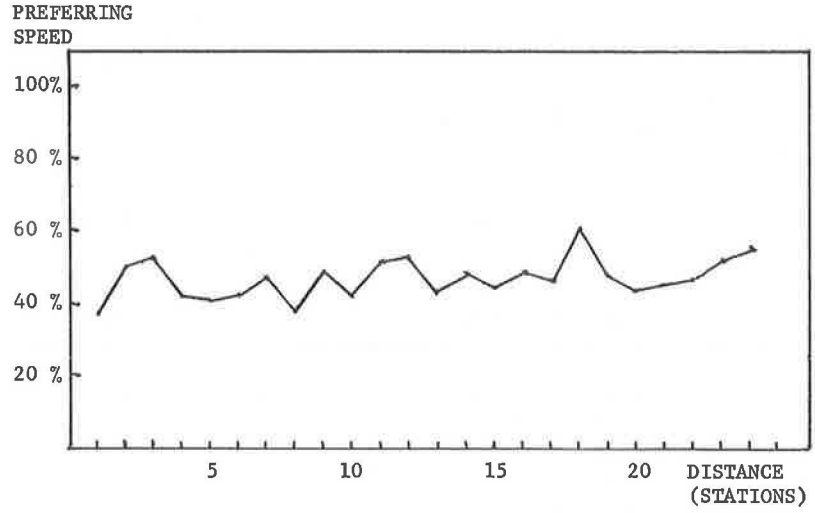

Figure 5. Percent of Passengers Using the Local/Express Mode as a Function of Distance to Their Destinations.