ALTERNATE USES OF A BUS STOP AT A MODAL TRANSFER POINT

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In theory, urban bus stops are for the exclusive use of buses. Practice shows that many different vehicles use the bus stop for a variety of purposes. This project examines the nature of these alternate uses and their effects on bus and traffic operations. The method used was the limited case study. A single, busy bus stop in Brooklyn, New York, was observed during both peak and off-peak periods. It is along a major arterial with commercial strip development where parking is allowed. The bus stop is at a rail rapid transit station that is a link to the Manhattan central business district. Data were collected by means of time-lapse photography. The findings indicate that the alternate uses of the bus stop increase the efficiency of the use of the curb. Bus operations benefit through the reduction of bus dwell times, and the increase of delay to traffic is minimal. The nature of alternate operations does not tend to be inherently unsafe.

•ALTHOUGH bus stops within a city are generally set aside for the exclusive use of the bus, even a casual observer will notice that, in practice, the bus stop actually has many alternate uses. The bus stop becomes a convenient open space in the crowded urban area for people to store vehicles to conduct their business. Drivers enter the bus stop with their automobiles to drop off or pick up passengers or perhaps to quickly purchase a newspaper or mail a letter. Commercial drivers see the vacant curb along a bus stop as an ideal place to park their vehicles for a delivery, and taxicab drivers use the space for the exchange of passengers.

Several questions about these alternate uses naturally arise. First, how is the bus stop used? The actual alternative uses of the bus stop must be determined. Such factors as vehicle type, duration of stay, location along the bus stop, and trip purpose need to be known to understand exactly how a bus stop is used. Patterns of use stratified by these and other variables need to be identified if they exist.

Second, and more important, what is the effect of these alternative uses on regular bus and traffic operations? When other vehicles use a bus stop, do these uses represent an interference with normal bus or traffic operations, or are they a more efficient use of the curb? The effect of each group of users on bus operation, if any, must be separated and determined from the others. Perhaps there is only a single group of users that adversely affect operations. It is expected that this study will give some insight into the effects of the alternate uses on bus operations.

The method of study for this report was the limited case study. A bus stop representative of a busy urban location with a large number of alternate uses was selected. The bus stop is an interchange point with the New York City Rapid Transit System and is along a major arterial with commercial strip development. There is a newsstand across the sidewalk from the bus stop.

Data were collected by time-lapse photography during a morning peak period, an off-peak period, and an evening peak period. Although the scope of the study was limited to the observation of a single bus stop, the location was selected because of its heavy use, and different times of the day were studied to determine if patterns found varied as the time of day varied.

DATA COLLECTION

Equipment

A method is needed that allows for repeated observation of an activity. The nature of the operations is such that all the characteristics used cannot be recorded at once by one observer. Since a large field crew was neither available nor desirable, the decision was made to collect data through time-lapse photography.

The equipment consists of a standard super 8-mm motion picture camera with a tripod and an intervalometer capable of photographing at various speeds. The speeds selected for data collection were one frame/2.5 sec for the peak periods and one frame/5.0 sec for the off-peak period. The speed was sufficiently fast to allow the data collected to be representative of the activity at the site.

Site Selection

There are several goals to satisfy in the selection of a good site. The site must have a high level of activity and must be frequented by many buses to ensure interaction between regular bus operations and the alternative uses by a variety of vehicle types and purposes of use. This will allow categorization of the uses so that they may be properly described.

The site also should be representative of the urban area. From the possible types of locations, one should be selected that will allow the conclusions drawn from the data to be used, in so far as possible, by others in urban areas. The decision was made to observe a location along an arterial roadway with commercial strip development. It was felt that such a site is typical of many urban locations. Local streets within the central business district were not considered because the effect of alternate vehicular uses on bus operations might not be able to be separated from other traffic situations affecting bus operations.

The location selected was the northwest corner of Church Avenue at East Eighteenth Street in Brooklyn, New York (Figure 1). Church Avenue is an arterial street in Brooklyn. There are two lanes in each direction, and parking is allowed in both directions. This results in one lane of travel for each direction. The bus stop is 85 ft (26 m) long and can accommodate two buses.

The bus stop is served by the active bus route B-35, which passes in both directions. Headways during peak periods are scheduled at 3 min, and, during the midday off-peak period, headways are scheduled at 4 min. The average headways conform to schedule. The peak-period bus headways are both exponentially distributed.

The site is an interface point with a New York City Transit Authority subway station. This D subway line provides a link to the Manhattan CBD. The curb space outside the station is therefore used as an automobile and subway passenger exchange point. There is also a newsstand across the sidewalk from the bus stop, and many drivers stop to purchase a newspaper. Because of the commercial strip development, the curb also provides storage for vehicles during the midday for commercial delivery and shopping trips.

Reduction Methodology

A method for the reduction of the data to a useful form was developed. Data were recorded by operations, each of which consisted of a single-vehicle use, from the time it entered the study area until the time it left. The study cordon is defined as the full length of the bus stop by one-lane width into the street. Data were reduced with the aid of a stop frame analyzer.

This allows examination of the film on a frame-by-frame basis. The number of frames that a vehicle remained within the cordon and other useful information about the operation were recorded. After the data were reduced, processing was computer aided to make output useful.

DATA ANALYSIS

Data were analyzed to determine the answers to three basic questions:

1. What are the effects of alternate vehicular use of the bus stop?
2. What is the nature of these alternate uses of bus stops and what about these uses interferes with the bus and traffic?
3. What are the safety aspects of these alternate uses?

The new data are analyzed from two perspectives. First, data must be considered from a time-occupancy viewpoint to determine how the bus stop is occupied with relation to time. This allows a feel for the magnitude of the differing types of operations. The potential for vehicular interactions with the bus can be determined with respect to the portion of time interaction is possible.

Second, data must be considered from an operations viewpoint to determine the effect of alternate vehicular interaction with the bus. In this approach the characteristics of each operation are observed. This will allow insight into the effects of alternate use and into the nature of the alternate use.

The existing data, consisting of accident reports, will be examined for the study area. This will give insight into the safety of alternate operations.

Definition of Terms

In the data analysis there are some terms and concepts that must be defined. They are as follows:

1. The study area consists of the entire length of the bus stop by the width of one lane of roadway.
2. Operations concern the use of the bus stop by a single vehicle.
3. Dwell time is the total time spent by a vehicle within the study area.
4. Interaction with a bus occurs when a vehicle is within the study area and a bus arrives and is not stopped at the curb. If a bus arrives and is stopped at the curb, no interaction is assumed to occur.
5. Location is the position along the curb of the bus stop. Because of the land use pattern at the bus stop and the size of an automobile relative to the bus stop, the bus stop is divided into three sections. Location 1 is at the front of the bus stop, and location 3 is at the rear (Figure 2).
6. Placement is the distance from the curb in which the right side of a vehicle stops. Placement is in three categories: Placement 1 was at the curb, placement 2 was a half lane away, and placement 3 was a full lane out from the curb. This level of refinement was the most allowed by the data collection equipment (Figure 2).
7. Free choice refers to the choice of operation characteristics. If, on arrival, the bus stop is vacant, then the arriving vehicle has free choice in its operational characteristics.
8. Restricted choice occurs when a vehicle arrives at a bus stop that is occupied by one or more vehicles. The choice of operating characteristics is restricted by the presence of occupying vehicles.

Time Analysis

A time use analysis of the bus stop affords a view of the magnitude of the types of operation that occur. The categories of the bus stop are (a) empty, (b) with a sole use, and (c) with shared use. The quantity of most interest in this case is the shared-use category. This is the only category within which an alternate use of the bus stop provides the potential for interaction with bus operations or traffic operations. The results are given in Table 1.

Most of the time (an average of more than 85 percent), the bus stop was either unused or used by an alternate (nonbus) vehicle alone. Shared use accounted for an average of 6.7 percent of the total time. From a time viewpoint, this seems an insignificant amount. During about one-fourth of the time in which the bus stop was shared, there was no interaction with bus operations; a bus arrived while another vehicle was in the bus stop, but the driver still brought the bus to the curb. The result is that, for slightly less than 5 percent of the total time, alternate use of the bus stop accompanied some displacement of the bus. Aspects of this displacement are discussed later. This displacement was most evident in the morning peak period when it occurred nearly 8 percent of the time.

Each of the categories of vehicle use had differing percentages of the bus stop occupancy as the time of day changed. The bus had its greatest share of the bus stop use during the evening peak period. Alternate use was most evident during the morning peak period.

A summary of the time use of the bus stop shows that shared use of the bus stop usually represents the lowest portion of time of any of the categories of use. Interaction with the bus from a time perspective, therefore, appears to be low compared with the time in which the bus stop is free of shared use.

A time use perspective is incomplete in its ability to totally describe the interactions of types of use. If the data are examined from the perspective of the bus rather than the bus stop, the view of interaction changes from a minimal to a major nature. The proportion of bus time shared with other vehicles varies from approximately one-third to one-half. The morning peak period is the heaviest shared period, in which 54 percent of bus time is spent with another vehicle.

This result shows that a more drastic interaction is possible when viewed from the operations perspective. The time analysis has provided an overall view of the amount of interaction. The effect of this interaction of alternative uses on bus and traffic operations can be better determined from an operations analysis. An operation in this case is the use of the bus stop by any vehicle.

Operations Analysis

Examination of the effects on bus operations will deal with the concept of free versus restricted choice. Qualities of operation will first be examined when the bus arrives and the bus stop is vacant. This represents the case where factors of operation, such as dwell time and placement from the curb, are chosen free from interaction with alternative uses of the bus stop. This result will be the control group against which the interaction is measured. Restricted choice represents those times when a bus arrives and there is at least one other vehicle within the bus stop. If there is a significant difference in the measured factor between the free and restricted choices, the difference is considered to result from the presence of an alternate use of the bus stop.

Effects of Alternate Use

Bus Dwell Time

Bus dwell time is a measure of the efficiency of bus operations. The shorter the dwell time is, the better the bus operation will be.

Significant differences in dwell times were found to exist between free and restricted choices during both peak periods. In these cases, the dwell times of the buses were significantly lowered by the presence of other vehicles within the bus stop. It appears that, in terms of bus operations, the quality of operation is actually enhanced by the

Figure 1. Study area, bus stop shaded.

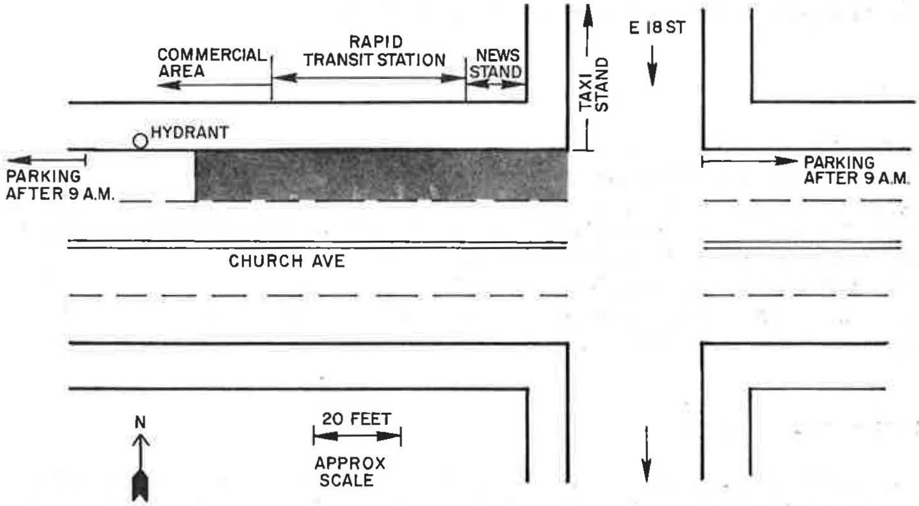


Figure 2. Location and placement in bus stop.

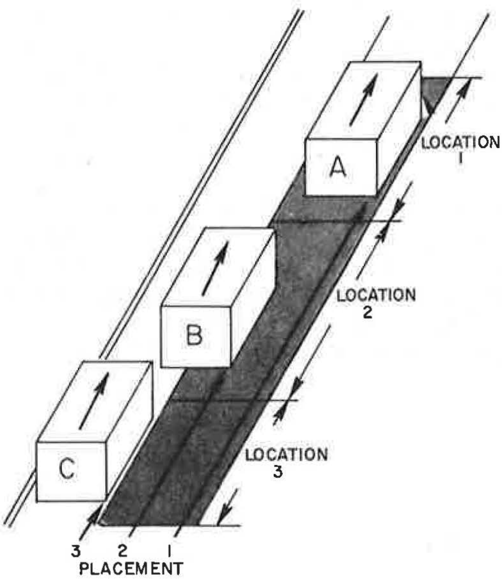


Figure 3. Bus placement versus dwell time.

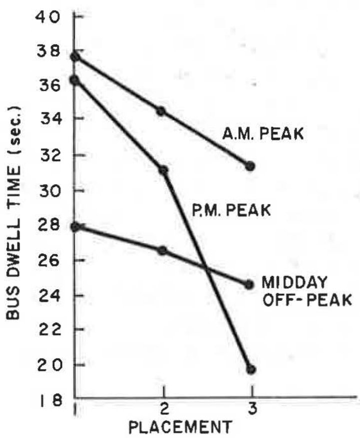


Table 1. Percentage of time period for different bus stop uses.

Use	Morning Peak	Midday	Evening Peak	Overall
Vacant	39.0	39.2	40.3	39.5
Bus only	7.7	5.4	10.7	7.9
Alternate only	44.3	50.7	42.6	45.8
Shared	9.0	4.7	6.4	6.7
Total	100.0	100.0	100.0	100.0[a]

[a]Approximately.

presence of other vehicles within the bus stop. An analysis will follow of the effects of bus location and placement on bus and traffic operations.

Bus Placement

In all cases, the difference in bus placement for free versus restricted choice was significant. Alternative use of the bus stop tends to displace the arriving bus an average of nearly half a lane into the traffic stream. Two effects of this result should be determined: the effect of such displacement on bus operations themselves and the effect of such displacement on the traffic stream.

The impact on bus operations can be measured by comparing bus dwell times with bus placement. If a relationship between bus dwell time and placement can be established, it can be used as a measure of the effect of bus placement on bus operations.

Bus Placement Versus Dwell Time

The impact on traffic operations is measured by a comparison of lane minutes of delay in two cases. The first case is a measurement of lane minutes of blockage by the bus with operations as they exist, that is, with a mix of free and restricted choices. The second case is a simulation of the lane minutes of delay caused by bus operations with only the characteristics of operation associated with free choice. The difference of delay in these two cases is attributable to the alternative uses of the bus stop.

Figure 3 shows the means of bus dwell times stratified by bus placement and by time of day. In all cases there is nearly a straight line relationship between distance from the curb and dwell time. As the bus is placed further from the curb, the resulting dwell time of that bus decreases nearly directly. This result can account, therefore, for the previous result of reduction of bus dwell time when a restricted choice was offered to the approaching bus. The conclusion is that the impact of alternate uses on bus operations tends to improve operation from the viewpoint of bus dwell time.

The reason for this reduction in dwell time appears to be related to the reduction of bus maneuvering. As a bus is placed farther out into the traffic stream, there is less impedance of bus operations. The bus driver is no longer required to move the bus out of the traffic stream to exchange passengers and then to wait for an acceptable gap to reenter the flow. The driver merely stops in place, exchanges passengers, and then continues on. The efficiency of bus operations is thus increased.

The delay calculation to determine the effect on the traffic stream is shown in the following equations:

$$\text{Delay} = (\text{dwell}) \times (\text{lanes blocked}) \times (\text{buses})/(\text{hours of observation})/60 \quad (1)$$

$$\text{Total delay} = \text{sum of delays under consideration} \quad (2)$$

The units of measure are lane minutes per hour. These calculations are given in Table 2 for the bus stop studied. The dwell is associated with the fraction of the number of lanes blocked. This is derived from the relationships for dwell and placement in Figure 2. The fraction of the number of lanes blocked is derived from the placement data.

As given in Table 3, the elimination of alternative uses in each case would cause a reduction in delay to the traffic stream. All of the delay, however, would not be reduced. This can be attributed to the fact that, when offered a free choice, the bus driver does not always stop the bus directly at the curb. The evening peak period offered an exception to this case because, when offered a free choice, the drivers always did place the bus at the curb. This may be due to the nature of the evening peak when the passengers are for the most part boarding the bus and the driver may be more apt to place the bus closer to the boarding passengers.

The reason for this behavior, however, is not so important as the fact that times exist when the bus stop is empty and the bus is not driven to the curb. Even if the bus is closer to the curb during a free choice than it is during a restricted choice, the result may differ from bus stop to bus stop. The quantity to indicate whether this behavior will result in a positive or negative impact on the traffic stream is the product of dwell times the number of lanes times the number of buses per unit time period. Dwell is the average dwell time of a bus at the specific fraction of lanes that it is away from the curb. The lanes are the fraction of lanes the bus is away from the curb. Thus, the traffic delay due to the alternate use of the bus stop can be measured as follows:

$$D = D_{op} - D_{fc} \qquad (3)$$

and

$$D_{op} = (d_f)(b_f)(n_f) + (d_r)(b_r)(n_r) \qquad (4)$$

and

$$D_{fc} = (d_f)(b_f)(n_f + n_r) \qquad (5)$$

where

D = delay attributable to alternate uses,
D_{op} = total delay with normal operations,
D_{fc} = simulated delay with no alternate uses,
d = average bus dwell under D_{op} and D_{fc},
b = average number of blocked lanes under D_{op} and D_{fc},
n = number of buses per hour under D_{op} and D_{fc},
f = free choice, and
r = restricted choice.

In the case of traffic delay due to alternate use of the bus stop, the effect of alternate uses of the bus stop on the traffic stream is to only slightly increase the amount of delay. Final policy decisions would involve a weighting of factors. In the study case, the alternate uses improved bus operations slightly and decreased traffic efficiency slightly. This trade-off must also be weighed in the overall context of the amount of time within which there is an interaction between the bus and other vehicles at the bus stop.

Nature of Alternate Use

To gain insight into the nature of use of the bus stop by other vehicles, a similar type of analysis will be done. Using the free versus restricted approach would be meaningless as it is not the concern of this report to determine the interaction of alternate vehicles with other alternate vehicles. The categories of dwell, placement, and location will be examined because they describe the use of the bus stop as they interact with the bus and traffic.

Alternate Dwell Time

Dwell time of alternate vehicles will be examined to determine if there is a critical dwell time that, when exceeded, may make it more possible for a vehicle to interact with the bus.

Data were sorted into a frequency distribution of dwell times for alternate vehicles stratified by whether or not a bus arrived during the operation. The data show that there is relatively no interplay with the bus until a dwell time of 50 sec is reached. After this point, the fraction remains fairly constant until a dwell time of greater than 200 sec is reached. After this point, a bus nearly always arrived. This is as expected because the average bus headways range from 180 to 240 sec. It would appear that those types of alternate uses that exceed 50 sec begin to have an effect on bus operations. Table 4 gives the mean dwell times for both vehicle types and trip purposes.

Those operations that are associated with passenger exchange result in dwell times of less than 50 sec. They include the bus, the taxi, and to some extent, the automobile. The automobile as a vehicle type functions not only as a passenger exchanger but also as a shopping vehicle, and, as shown by Table 4, passenger exchange is the shortest of the dwell times. This indicates that the automobile has shorter dwell times when used for passenger exchange.

The evening dwell time for the passenger exchange trip purpose is somewhat longer than the rest. This could be due to an additional waiting period attached to a passenger pickup. That is, the driver of the automobile waits for the passenger to arrive at the bus stop from the transit system below. During the other time periods, passengers are generally being dropped off, and there is no additional dwell time associated with the operation.

Alternate Vehicle Locations

The location of vehicles within a bus stop may have an effect on bus dwell times and thus affect bus operations. To determine if this effect exists, bus dwell times are compiled and stratified by alternate vehicle occupancy of the curb and time of day. The occupancy patterns are then listed in the order of the associated bus dwell times and examined to see if some pattern of alternate vehicle occupancy caused a change in bus dwell times.

The results were examined to see if the trend of bus dwell time tended to increase as the occupancy shifted from front to rear or vice versa. The only discernible pattern occurred during the evening peak period when the bus dwell times tended to increase. As the rear of the bus stop became progressively unoccupied, bus dwell times were the lowest. When the rear was vacant but the middle was occupied, the dwell times were within the next lowest class. This pattern was consistent for all occupancy patterns of the bus stop during this time period. Occupancy of the rear of the bus stop would have the tendency to force the bus to be placed farther out into the traffic stream. This is consistent with the prior results of displacement from the curb being associated with reduced bus dwell times. This is also consistent with increased traffic delay.

Given that the location of an alternate vehicle may have an influence on bus and traffic operations, it is desirable to observe if the locations of vehicles tend to be related to land use. If this were the case, one might influence the effect of alternate uses on bus and traffic by changing the land use pattern of the bus stop. Figure 4 shows the location of alternate vehicles along the bus stop when there is a free choice of location. The vehicles were separated into two general classes of trip purposes: passenger exchange and commercial trips. The latter includes shopping trips and commercial deliveries.

The land uses along the bus stop are such that the entrance to the transit station is opposite location 2. Thus, if the locations were affected by land use, one would expect a tendency of vehicles for passenger exchanges to stop at location 2. Location 1 has various shops opposite it, and location 3 is directly opposite an active newsstand. One would expect commercially oriented trips to focus on these locations; this is indeed

Table 2. Traffic delay calculations for bus placement.

Category	Dwell Times	Lanes Blocked	Number of Buses	Hours of Sample	Delay (lane min/hour) Avg	Total
Case 1[a]						
Morning free	37.2	0.11	9	1.76	0.35	
Morning restricted	36.6	0.21	25	1.76	1.81	2.16
Midday free	26.3	0.60	31	4.12	1.98	
Midday restricted	26.0	0.67	37	4.12	1.90	3.88
Evening free	36.6	0	16	1.52	0	
Evening restricted	32.0	0.43	14	1.52	2.11	2.11
Case 2[b]						
Morning free	37.2	0.11	34	1.76		1.32
Midday free	26.3	0.60	58	4.12		3.70
Evening free	36.6	0	30	1.52		0

[a]Operations as they exist. [b]Simulation, bus stop always vacant on bus arrival.

Table 3. Traffic delay due to alternate use of bus stop.

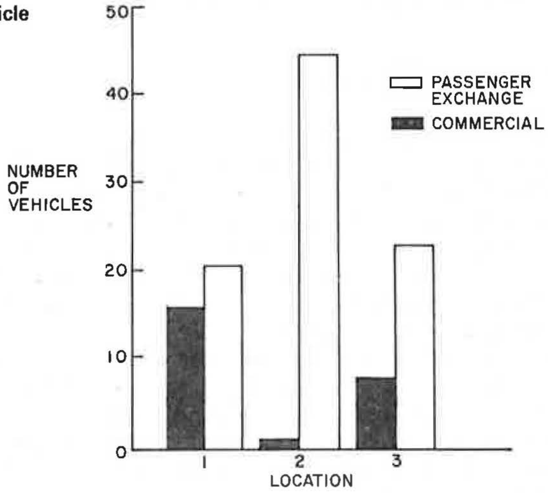
Time	Delay (lane min/hour) Case 1	Case 2	Due to Alternate Uses
Morning	2.16	1.32	0.64
Midday	3.88	3.70	0.18
Evening	2.11	0	2.11

Table 4. Mean dwell times for vehicle type and trip purpose.

Item	Morning	Midday	Evening
Vehicle type			
Automobile	48	116	110
Light truck	111	506	57
Heavy truck	320	518	–
Bus	34	26	33
Taxi	39	35	46
Trip purpose			
Passenger exchange	34	29	61
Shopping	99	176	144
Commercial delivery	244	524	72
Other commercial	298	365	–

Note: All values are in seconds.

Figure 4. Free choice of alternate vehicle location based on trip purpose.



the case (Figure 4). Therefore, location of alternate vehicles along the curb does appear to be related to land use.

Alternate Vehicle Placement

The placement tendency is such that, when drivers are offered a free choice, they usually place their vehicles at the curb. The exception was the morning peak period when 7 of the total 49 vehicles placed a half lane from the curb. Six of these seven vehicles were taxicabs.

When a restricted choice is offered an alternate vehicle, it is interesting to note whether location or placement is favored; that is, when the bus stop is partially occupied, will a vehicle place out into the traffic stream to be closer to its associated land use or will it place farther away along the bus stop to be out of the traffic stream? The trips were again separated into the commercial and passenger trip purposes. Each was considered separately. For passenger exchange, the curb-occupancy patterns examined were those in which location 2 was blocked but another location was available for use. For commercial trips, those occupancy patterns examined were those in which one or two of the commercial locations (1 and 3) were occupied and the center of the bus stop was available for use.

The result is that, when forced to choose between location and placement, the driver will usually place the vehicle out of the traffic stream and away from the desired location along the bus stop. This is good from the traffic viewpoint. Vehicles are usually stopped out of the traffic stream, and, therefore, cause a minimum of traffic interference.

SAFETY ASPECTS

Accident reports were available from the traffic department for a 2-year period from January 1970 to December 1971. There were 27 vehicle accidents at this intersection during this time period. Of these 27, 3 occurred in the area of the bus stop studied. In all three cases the accidents do not appear to be unique to the alternate uses of a bus stop. They could have occurred anywhere. The conclusion is that alternate uses of the bus stop do not tend to cause accidents.

SUMMARY AND CONCLUSIONS

This has been a case study of a single bus stop located along an arterial with commercial strip development where parking is allowed. The operation of this bus stop has been analyzed for both peak and off-peak periods. The analysis of the bus stop operation has yielded conclusions in several areas. These conclusions follow.

Shared use of the bus stop represents the least amount of time use of any of the categories. Shared use occurs when a bus and another vehicle use the bus stop at the same time. This indicates that the potential for alternate use of the bus stop to interfere with operations is minimal.

Alternative uses of the bus stop affected changes in bus dwell times and the placement of the bus from the curb. When, on arrival, the bus was occupied, the bus stopped farther out into the traffic stream than when the bus stop was vacant. However, this displacement resulted in a reduction in bus dwell time and thus improved bus operations. There is nearly a straight line relationship between bus displacement and reduced bus dwell time.

Because the bus blocked traffic for a shorter period, some of the delay to the traffic stream caused by the displacement of the bus was cancelled by the shorter dwell time. Equations were developed to measure the change in delay if there were no alternate uses of the bus stop. In the study case, alternate uses of the bus stop accounted for less than 3 lane min/hour of delay. This delay is a minimum because not all the delay to the traffic is due to alternate uses. The bus drivers do not always stop at the curb when the stop is vacant; therefore, there is some inherent blockage of traffic operations without alternate uses.

Therefore, the reduction of delay to traffic by the restriction of alternate uses is minor. This is especially true when compared with the more efficient use of the curb that alternate uses afford; that is, if the bus alone used the curb, it would be unused for better than 92 percent of the time. When alternate uses are present, the curb is unused for less than 30 percent of the time. This is of great benefit to the vehicles using the bus stop (including the bus) at the cost of a minor additional delay to the traffic stream.

Trips associated with passenger exhange had the shortest dwell time. Commercially oriented trips had longer dwell times and thus were more likely to interact with the bus. In addition, there was some indication that, as the rear of the bus stop became progressively vacant, the bus was placed closer to the curb.

Vehicles tended to locate nearest to their related land uses. This indicates that the effects of alternate uses might be controlled by controlling land use at the bus stop.

When drivers are offered a frustrated choice of curb space, vehicles will be parked farther away from the desired land use rather than be double parked closer to the destination. This is good from the viewpoint of traffic operations.

The accident reports for the study area for a 2-year period indicate that there is no special or inherent danger in the alternate uses of the bus stop.

The alternate uses of the bus stop greatly increase the efficiency of the use of the curb. There are benefits to those who use the bus stop because more curb space is available to them. Bus operations also benefit by a reduction of dwell time due to the reduced need to maneuver into and out of the traffic stream. The cost is shown to be only a minor delay to the traffic stream. In the study case, this delay was less than 3 lane min/hour.

This has been a limited case study, and further research is needed. The results obtained indicate that the presence of alternate uses of the bus stop increases the efficiency of the use of the curb. Bus operations benefit through the reduction of bus dwell times. The penalty of the alternate uses is a minimal increase in traffic delay, and the cost is small when compared with the benefits.

ACKNOWLEDGMENT

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DISCUSSION

Colin H. Alter, Maryland-National Capital Park and Planning Commission

For too many years, the use of bus stops as intermodal transfer facilities and as minor activity points has been ignored. This paper will definitely stir further research, and, it is hoped, also stir transportation planners to think about the simple, everyday problems of mobility. These reasons alone are sufficient to warrant wide dissemination of the paper, whether one agrees or disagrees with the conclusions.

There are, however, many reasons to debate the conclusions of the paper: The scope of the study appears to be excessively narrow, important research items are missing, and numerous questions are left unanswered.

The primary orientation of the paper is the physical operation of a bus stop. To that extent, it has failed to examine the needs of people. For example, safety was reviewed solely from the perspective of intervehicle accidents. The experience of pedestrian accidents is not revealed. More important, the incidence of boarding and alighting accidents to bus riders is not reported. In checking with personnel from several transit operations, I found that they unanimously agreed that boarding and alighting operations away from the curb were significantly more hazardous for riders than curb operations were. The problem is most severe for the elderly and women, but includes all riders during inclement weather. There appear to be two reasons for the problem: the increased height from the ground to the first step of the bus and moving vehicles between the bus and the curb. One of the transit operations stated that 15 percent of all claims over a 1-year period were for these types of accidents.

There are other information needs about bus stop use: What percentage of people using the bus stop were bus stop passengers? Do discomfort and decreased safety for riders boarding and alighting away from the curb equate in some benefit-cost analysis to the ease of loading and unloading at the curb for alternate uses? In evaluating this last problem, the number of people, not vehicles nor time, is the important criterion. This paper has ignored this issue.

As a separate technical issue, the amount of linear curb space necessary for a far-side bus stop for a single bus should be between 60 and 65 ft (18 and 20 m). A minimum of 6 ft (1.8 m) at the corner is required for a crosswalk. This crosswalk is the final maneuvering space of the bus. The bus itself is 40 ft (12 m) long (considering only the 50 to 53 passenger buses that are standard in most cities). In addition a bus stop must have an unobstructed 20 to 25 ft (6 to 7.6 m) (depending on the skill of the bus operator and the width of the roadway) to return to the traffic stream. Thus, the 62 ft (19 m) for the bus stop discussed in the presentation may be adequate for one bus, but not two, as asserted by the authors.

It is also necessary to explore bus operating speeds beyond the limited scope of the paper. Urban bus speeds in local service generally average between 10 to 12 mph (16 to 19 km/h). Since buses can theoretically travel at the same speed as other vehicles in traffic, a major reason for their slowness is the necessity to decelerate, manuever into the bus stop (for near-side stops) or out of it (for far-side stops), load and unload passengers, then reaccelerate to traffic flow speeds, only to repeat the process a block or two away. On congested transit routes similar to those discussed in the paper, the significant dwell time (as confirmed in the paper) is the time spent manuevering the bus into and out of the traffic stream.

The paper discussed the interference of curb operations of the bus as a benefit to bus operating times, due to the reduced need to change lanes. (In the case of this particular stop, there is no apparent difficulty in the bus manuevering out of the traffic stream to the stop since it is on the far side of the intersection.) The key problem is returning to the moving traffic lane. This problem is as much a legal problem as a traffic operations one. The solution appears obvious: Revise motor vehicle laws to grant public transit vehicles the right-of-way at all times. Nationally, it is important; in high-density urban areas it is vital if dwell times are to be reduced and passenger safety is to be improved. The conclusions of this paper are simply unsatisfactory.

It is necessary to reiterate that this paper is an important contribution because it has stimulated thought on the problem of multiple uses of bus stops. Loading and unloading problems and their accompanying dwell time delays are critical and conscious nuisances to riders. These problems are exacerbated by illegal alternate uses of the bus stop during those times that buses need to use it. The authors are correct when they urge more research in this area; also needed are the day-to-day experience of transit managers and their input.