Investigating Strategies to Improve Bus Transit Operations

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Abstract

Transit agencies, particularly now, have to deal with operating issues. Ridership is growing but with the costs are as well. Across the country, ridership has been increasing but agencies do not have the money to add more service or purchase new buses. Various approaches are used by transit agencies by employing a judicious mixture of strategies as appropriate at the route level. A scan of the literature on operating strategies shows that a variety of strategies have been applied in different settings in various transit agencies. The Chicago Transit Authority (CTA), the case study of this research, currently employs several of these operating strategies – short-turn and deadheading. These strategies will be evaluated for their effectiveness.

The CTA is facing a tremendous burden on its resources (both operating and capital) in light of the constrained funding scenario for transit in this region. It is in this context that this research assumes significance. The various operating strategies employed by the CTA are studied for context, relevance, and impact based on a comprehensive review of CTA schedules (from HASTUS) coupled with interviews with the appropriate personnel from the agency.

The paper will discuss the benefits of the various operating strategies highlighted in the literature, followed by an analysis of the current practice at CTA at the route level. The lessons learned from the existing practice and the literature will be used to develop an evaluation of a specific route with the strategies added to its operation. The benefits as well as the costs will be discussed.

Key words: Operating Strategy, Bus, CTA, Short-turn, and Deadhead.

Introduction and Background

The CTA has been experiencing growth in the bus system over the past year as a result of investments in the system and fluctuation of gas prices. Investments in the system include the restructuring of express bus services on the Western Avenue, Irving Park Road and Garfield Blvd/ 55th Street corridors and realigning bus routes to serve growing demand. The growth in ridership outpaces the procurement of new vehicles. In addition, over 200 buses made by North American Bus Industries were recently removed from service as a result of safety concerns. The combination of this two unforeseen events along with others have placed a strain on the CTA's resources and jeopardizes its ability to be able to sustain the growth and hold onto the new passengers. The purpose of the research is to look at current CTA practices at strategies to address capacity and efficiency issues which will help reduce the need for new vehicles while providing the service that is necessary.

The strategies are short-turning and deadheading. Short-turn operation occurs when a trip does not operate from terminal to terminal, rather from a terminal to a midpoint along the route or from two points that do not correspond to the full-time terminals. This strategy can be built into the schedule or used to correct a real-time delay in the system. Deadheading occurs when a bus runs express without carrying any passengers to a location.

The paper, which follows an on-going research project, will be structured in four parts: the Literature Review, an Overview of Current Use of the Strategies, a summary of a Questionnaire with CTA employees and the Next Steps.

Literature Review

Previous research has linked short-turning and deadheading with efficiency and capacity issues. The strategies have been used by the CTA for over 40 years to manage capacity and efficiency. Even though they are commonly employed by agencies, there is a limited amount of research done on their effects on the system.

Short-turn operation of bus routes is a solution to both capacity and efficiency issues. Capacity and efficiency are closely linked in the transit world. If there are buses that are operating empty, the buses are less productive which leads to route inefficiency. Avishai Cedar wrote a paper on creating an optimal design of short-turn trips stating that in order to minimize inefficiency, remove trips beyond the point of usefulness (Cedar, 1989).

Peter Furth argues that short-turns can be done to balance loads on buses which can increase overall efficiency. When buses are operating at capacity, increases in dwell times often lead to bunching and reducing the reliability of the route. Short-turns, if scheduled with an offset from the full-length trips can be used as a medium to reduce crowding and improve the overall efficiency of the route (Furth, 1987).

Nigel H.M. Wilson et al. authored a paper investigating strategies to improve service along the MBTA's Green Line Light Rail system. The line, with four branches, was plagued by delays that ricocheted throughout the system. The collection of researchers determined that three strategies were appropriate for the system, short-turning, deadheading and expressing with the latter skipping stops while in revenue service. Before the recommendations were made, supervisors made the call of which trains would short-turn, deadhead or run express based on his or her judgment. The recommendations outlined which strategy should be used and when in order to reduce the impact on the Green Line passengers, particularly those on the branches to the south and west of the Central Subway. Although this paper deals with real-time situations, it can be said that if there is a pattern of delays, solutions can be built into the schedule to minimize the delay's effect on capacity and overall route efficiency (Wilson, Macchi, Fellows, & Deckoff, 1992).

Overview of Current Use of Strategies

Based on the findings from the literature, the strategies to be further studied are short-turning and deadheading. The CTA currently employs both strategies to deal with capacity and efficiency issues. As part of the research, a matrix of current routes that use either strategy was developed. This matrix divides the two general strategies into more defined terms and the routes were divided into different categories based on geography.

The divisions seen in short-turning and deadhead were created based on the data collected from the CTA. In general the CTA employs short-turns in three manners: operating only in the peak direction, operate bi-directionally during a specific time period or operate bi-directionally at all times. For deadheading, routes either operate in the peak direction only (into downtown in the morning, away from downtown in the evening) or operate bi-directionally during the span of service. The route categories were supplied by the Data Analytics department at the CTA.

Based on the matrix, individual route profiles of existing routes were created. This profile details the use the strategies for each route, including the number of trips that use either short-turning or deadheading as well as the number of trips that do not. The route profile's purpose is to understand how the strategies are being used in the schedule for each route. Combined with the matrix, an insight into CTA's usage of the strategies can be seen. Table 1 is a brief overview of the route profile for the 151- Sheridan route which runs from the North Side into Downtown.

Table 1

151- Sheridan						
Trip Direction	**Strategy**	**Pre- AM**	**AM Peak**	**Midday**	**PM Peak**	**Evening**
Southbound to Downtown	Regular	8	15	28	23	N/A
Southbound to Downtown	Short-Turn	1	23	27	8	N/A
Northbound to Edgewater	Regular	N/A	13	27	25	29
Northbound to Edgewater	Short-Turn	N/A	0	0	5	9
Northbound to Lakeview	Short-Turn	N/A	10	27	17	4
Northbound to Lakeview	Deadhead	N/A	2	0	0	0
Northbound to River North	Short-Turn	N/A	5	0	0	0
Northbound to Nature Museum	Deadhead	N/A	2	0	0	0
SB % of Total Trips Using Deadhead		11.11%	60.53%	49.09%	25.81%	N/A
SB Ratio Deadhead to Regular Trips		0.125	1.533333	0.964286	0.347826	N/A
NB % of Total Trips Using Short-Turning		N/A	46.88%	50.00%	46.81%	30.95%
NB Ratio of Short-turn to Regular Trips			1.153846	1	0.88	0.448276
NB % of Total Trips Using Deadheading		N/A	12.50%	0.00%	0.00%	0.00%
NB Ratio of Deadhead to Regular Trips			0.307692	0	0	0

As you can see from the table, the usage of the strategies varies by direction and time. The Northbound trips in the morning uses both short-turning and deadheading while the southbound trips only use short-turning. The route profile was done for the other 27 routes in the system that uses either short-turn or deadheading.

CTA Questionnaire

A major part of the research consists of a questionnaire that was distributed to various CTA employees in the Planning & Development and Bus Operations departments. The questionnaire consists of 26 questions covering the interviewee's CTA background, familiarity of the system, their perspective on potential issues pertaining to capacity, demand and efficiency as well as potential solutions to the issues including currently used strategies of deadheading and short- turning. The interviews took place over a three day period.

The respondents primarily work within Planning & Development, particularly Service Planning and Scheduling or Bus Operations. Service Planners have the task of creating, maintaining and refining all of the bus routes system wide. Schedulers have the task of creating schedules based on the service determined by service planning. Schedulers also create the crew schedules and try to keep the costs of operating a route minimized. The length of time within the respective departments varies from as little as 1 year to nearly 25. For some employees, their current position in the department is the only one they have had while employed at the CTA while others had several positions in different departments.

In terms of efficiency on a route level, an over whelming majority of respondents believed that the system was somewhat efficient. The only garage to be suggested as very efficient was the Chicago Garage. All of the respondents believe that an imbalance of demand exists in the system. This imbalance is seen in two ways: a strong directional demand and a concentrated demand on a corridor (for example, the eastern portion of a route has more demand than the western portion). Routes with the most mentions include the Lakeshore routes, the 74th Garage routes, and specifically, the 79-79th St route. This imbalance leads to efficiency as well as capacity issues. In terms of fleet capacity a split was seen among the respondent with a little more than half believing the current fleet is enough while just under half believing that there are not enough buses, specifically the 60' articulated buses. The CTA recently removed from service 200 articulated buses as a result of an issue with the structural integrity of the buses.

When asked to rank, in terms of importance, which department would be the source of the solutions to what they believe the problems are, the respondents, on

average, said that Scheduling was the most important followed by Bus Operations then Service Planning.

It is expected that implementing new ideas would incur some resistance either institutionally or operationally. When asked of the institutional barriers, respondents frequently mention the lack of communication between Bus Operations and Planning & Development. In order to make the necessary improvements, both sides must be able to effectively discuss the feasibility of the improvements as well as any necessary changes in order to do so. The other major institutional barrier is the lack of financial resources. Ideally, the respondents want to improve their routes but it can be very costly. Many of the respondents take the "cost-neutral" approach, by reallocating resources to make any changes. This means some routes may lose service to add service on another route. The reallocation may be wholly within a route such as a wider headway to extend the service span. On the operations side, the major barriers mentioned by the respondents are the lack of layovers/ turnaround locations as well as storage location for buses. Respondents explain that it is difficult to find a suitable layover location to provide amenities for the drivers to take a break or to use a restroom. These layovers/ turnaround locations must be able to hold more than one bus at a time; otherwise the buses are lining up waiting to pull into the layover causing a block in traffic. This problem is physical problem but it is also an issue in the community with residents and business owners against the idea of a bus parked on their street.

The second half to the questionnaire focuses on two specific strategies, short-turning and deadheading. The first portion focuses on short-turning specifically while the latter focuses on deadheading. Short-turn trips only operate for a portion of the route while deadhead trips operate express as a non-revenue trip. When asked about familiarity with the two strategies, most respondents said they were very familiar. Respondents believe that the CTA uses short-turning as a strategy to realign service to match demand. This is done to either improve service by increasing the number of trips on a certain portion of a route or conversely to save on costs but reducing the number of trips on a certain portion of a route. When asked to rank the key secondary benefits of short-turning trips, respondents say route productivity is most important. Route productivity is the number of passenger boardings over one service hour. This is closely followed by

efficient use of available buses. This is especially crucial at the moment with a shortage of articulated buses system wide. Operator productivity was ranked last. Operator productivity is the number of trips an operator completes during a run.

Most agreed that short-turns are most effective when only operating in the peak direction to influence capacity. This is seen on the 22-Clark and 146- Inner Drive/ Michigan Express where short-turn trips operate only towards the Loop in the morning peak period. As a method to save on costs of operating a route, short-turns are most effective when operating at all times in both directions when the route is in operation. This is seen on the 71- 71st/ Commercial, 67- 67th/ 69th/ 71st and 79- 79th routes. The short-turn patters are usually determined based on the suggested service based on the Service Standards Analysis Tool. If the Service Standards Analysis Tool suggests a headway on a portion of the route that is less than half the rest of the route, it is usually a sign that short-turning is needed. While generally positive about the use of short-turns, the respondents were asked to rank the consequences of short-turns. In order from most important to least important, the consequences are potential bus bunching (or big gaps), induced transfers, increased supervision from bus operations and increased planning efforts to create an effective short-turn. Bus bunching can occur when the short-turn trip catches up to the lead trip thereby creating a big gap. A big gap can also occur if full-length trip experiences delays on a segment that the short-turn trip does not occur. Induced transfers occurs when passengers board a short-turn trip (due to not knowing the pattern or being passed up by a crowded full-length trip) must transfer to a full-length trip to reach the desired destination. Supervision from Bus Operations is required to make sure that the trips leave the short-turn terminal in a manner to keep the passenger loads even.

The final section of the questionnaire focuses on deadheading. Respondents agreed that deadheading buses within a route (trips that are not pull-ins, pull-outs or to interline) are done based on a strong directional passenger flow. Deadheading, which shortens the cycle time, helps to move buses into position during the peak period to add capacity to a route. When asked to rank in order of importance the secondary benefits of deadheading, route productivity was selected as most important. If the deadheads trips were in service and not carrying many passengers (if any at all), the route would become

less productive. The second most important benefit is the increased efficiency of available buses. Due to the finite number of buses, it's best to use them where they're needed. Thirdly was operator productivity.

Almost all respondents agreed that deadheading trips where only optimal is most effective to both influence capacity and cut costs. It can be optimal to run trips from terminal to terminal or only for a portion of the route. For example, the 151- Sheridan has a few morning trips that operate as a short-turn from Union Station to North Michigan Avenue then deadhead to the Nature Museum. It is not optimal to operate as a deadhead from Union Station to North Michigan Ave because there is no place to deadhead and demand exists for that portion of the pattern. When asked to rank the factors that determine the number of trips to deadhead (all trips or selected trips) respondents agreed that the strong directional demand in the peak direction is the most important factor. This is followed closely by little to no demand in the non-peak direction then duplicative services in the corridor. For example, the 148- Clarendon/ Michigan Express only runs in the peak direction during rush hour, service in the non-peak direction is not necessary due to the duplicative 145 that runs all day along similar corridors. Lastly, respondents believe that the reduction or eliminating of service in the non-peak direction, which directly affects passengers, is the most important consequence of deadheading.

Next Steps

The next step in the research is to study a route that had either short-turning or deadheading added to the schedule. The 62- Archer route was revamped recently with the addition of short-turns and an increase in the amount of deadhead trips. The evaluation of the success of the new schedule will be based on several factors:

1. Ridership change as a result of the reduced headway beyond the short-turn point.
2. The loading patters of the passengers
3. On-time performance
4. The number of vehicle hours saved if trips were eliminated or the number of new trips added if the same number of vehicles were kept
5. The total cost of operating the route.

The success of the 62 may lead to identifying other routes throughout the system that can use these strategies to improve efficiency and increase capacity.

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