INTERMEDIATE TIMEPOINT REMOVAL ON LIMITED-STOP ROUTES AT NEW YORK CITY TRANSIT

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REVISED

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ABSTRACT

Improving the speed and reliability of high-volume urban bus service is an important transit planning objective. One means of improving speed is to provide a limited-stop service alternative on heavy demand local bus routes. New York City Transit (NYCT) first began operating limited-stop bus service over 35 years ago to address customer complaints about slow travel speed. Customer response to limited-stop service has been overwhelmingly favorable, reflecting in part the reduced travel times and improved reliability on these routes. In an effort to further reduce travel times NYCT began a pilot program in the spring of 2010 to remove intermediate timepoints from the schedule of several limited stop routes. The goal of this pilot was to speed up service and reduce delays for customers already on-board the bus by eliminating holding for scheduled time. In general the pilot was expected to have an overall positive effect; however, one possible downside was the impact on reliability. The purpose of intermediate timepoints is to keep trips on schedule and without these timepoints it was possible that reliability would decrease. This potential negative effect was evaluated in the pilot study. Most previous research on this topic either speculates on or simulates the effects of timepoint removal, while the NYCT pilot program actually removed all timepoints from some limited-stop routes as a real-life experiment. This paper reviews the experience and findings of NYCT with respect to this pilot program using before and after measures of effectiveness, including running time, headway regularity, and customer perceptions. The key findings of this study are that timepoint removal from limited-stop service resulted in some reduction in travel time for most of the case studies, but slight if any changes in reliability, while customer perceptions generally improved.

1 INTRODUCTION

Improving the speed and reliability of high-volume fixed route urban bus service is an important transit planning objective. One method of increasing travel speed is to provide a limited-stop service alternative on heavy demand local bus routes. In general, limited-stop bus service is a variant of local bus service and makes stops at 8-10 block (0.5 mile) intervals, usually at major trip generators or transfer points to other bus or subway routes. New York City Transit (NYCT) first began operating limited-stop bus service over 35 years ago to address customer complaints about slow travel speed (1). Limited-stop service has grown dramatically since that time and NYCT now operates 41 limited stops routes. Ten of these routes operate seven days a week.

Customer response to these routes has been overwhelmingly favorable (1) reflecting in part the reduced travel times and improved reliability on these routes. However, there is still room for travel time improvements. Like most transit systems, NYCT utilizes intermediate timepoints on bus routes as a control strategy. This strategy helps to keep buses on schedule but also has the unfortunate tendency to annoy customers who are already on board the bus. To address this issue NYCT began a pilot program in the spring of 2010 to remove intermediate timepoints from the schedules of limited stop routes with the goal of reducing travel times on these routes. In general the pilot was expected to have an overall positive effect; however, one possible downside was the impact on reliability. Since the purpose of intermediate timepoints is to keep trips on schedule, without these timepoints it was possible that reliability would decrease. This paper reviews the experience and findings of NYCT with respect to this pilot program, including before and after measures of effectiveness, running time, headway regularity and customer perceptions.

2 LITERATURE REVIEW

Removing intermediate timepoints is one extreme on the spectrum of holding strategies. This section reviews prior research related to this topic.

Limited-Stop Service

Previous research on limited stop service includes (1) New York City Transit's experience with limited-stop service. This paper details the benefits of limited-stop service including improved operating speed and reliability, and provides guidelines for limited-stop service implementation. It also describes the coordination necessary when limited-stop service is implemented as an overlay to existing local service. Other limited-stop service research (2) looked at several case studies to develop feasibility and design guidelines for limited-stop service, with the key finding being that limited-stop service is most effective when greater than 50% of the service is limited-stop service on a route with both local and limited-stop service.

Service Reliability and Passenger Waiting Time

Research on wait times (3) found that for short headway service unreliability results in passengers budgeting significant extra time, referred to as "hidden waiting time" to account for the extreme of the waiting time distribution. Thus service reliability is shown to be a waiting time cost and therefore improving service reliability can reduce this hidden waiting time cost.

Timepoints and Schedules

Prior research on timepoints (4) looked at the number of timepoints on a route and how segment level running time was set in the schedule. This research found that passenger travel time is minimized with two timepoints and when schedules are set based on the 35th percentile value of

running time based on historical data. This research assumed that passengers time their arrivals to the schedule which is more applicable to long headway service. The author comments that where passengers arrive randomly as is the case for short headway service, the result still applies and that low percentile values of running time and holding points should be utilized to reduce passenger travel time and improve reliability. Other research (5) focused on how to develop a schedule for high frequency routes while balancing passenger waiting time and in-vehicle time, with the goal of improving reliability through better scheduling. The author notes that a typical scheduling rule of thumb used in practice is to set running time levels such that 65% of trips would have time to complete a route or segment. This research found that the schedules obtained through generalized cost minimization (minimizing the sum of passenger waiting time cost and in-vehicle time cost) could significantly improve reliability and overall service quality as compared to schedules set through typical rules of thumb. Another observation in this research is that for the routes analyzed timepoints were not strictly or consistently adhered to contributing to headway variability and unreliability. The author notes operator behavior and differences between operators as a significant source of headway variability.

Holding Strategies

Research on holding strategies (6) analyzed and compared schedule-based and headway-based holding strategies with a focus on short-headway service in. A maximum holding time for headway-based holding is introduced with the goal of minimizing passenger travel time. In general holding vehicles can improve reliability and reduce passenger travel time; the authors note that holding strategies in general are most effective when running time variability is high. The findings are that the optimal value of the maximum holding time increases as the running time variability increase. Furthermore, schedule-based holding was found to be more effective than headway-based holding when no maximum schedule-based holding time was applied, but there was no difference when it was set to 60 seconds. Furthermore, it was found that introducing an additional holding point did not further reduce travel times. Additional research on holding (7) found that "in an optimal schedule, each minute consumed by holding at time points reduces by 1 minute the holding time needed at layover". This result implies that holding at timepoints does not necessarily increase operating cost as long as this time is offset in the layover time. Experimental results showed substantial benefits from time point holding, and that these benefits increase as more stops become timepoints. This research also found that route level running time should be set at the mean plus one standard deviation of uncontrolled running time.

3 LIMITED STOP SERVICE AT NEW YORK CITY TRANSIT

Limited-Stop Service at New York City Transit

New York City Transit has over 690 million annual customers on 244 bus routes. Table 1 below provides additional NYCT bus statistics and further information can be found on MTA's website at www.mta.info.

Figure 1 displays a map with all NYCT transit routes shown in light grey, limited-stop routes in dark grey, and limited-stop routes without timepoints in red and identified by route.

TABLE 1: New York City Transit Bus Service Statistics

New York City Transit Bus Service Statistics
▪ 696 million annual customers ▪ 2.21 million daily riders ▪ 4,538 buses ▪ 2,070 bus route miles ▪ 244 bus routes o 208 local ▪ 41 have limited-stop variations ▪ 4 have Select Bus Service(SBS) variations o 36 express routes (premium fare) ▪ 26 Routes with >20,000 weekday riders

FIGURE 1: New York City Transit Limited-Stop Routes (2011)

Limited-Stop Service Description

Limited-stop service is a variant of local service with half-mile (2640 feet) stop spacing rather than 750 feet which is the NYCT standard for local stop spacing. The primary purpose of limited-stop service is to reduce travel time by increasing stop spacing. This allows buses to travel longer distances without stopping and reduces the overall trip dwell time by reducing the number of stops. Nearly all NYCT limited-stop routes have a local service variant running on the same corridor; both the local and limited-stop have the same route number but with the limited-stop route designated as "LTD" (i.e. B35, B35 LTD). The local service typically short turns at one or both ends of the route while the limited-stop service operates along the entire length of the route. The limited-stop service makes only limited-stops in sections where it overlaps with the local service, and all local stops on the rest of the route (Figure 2).

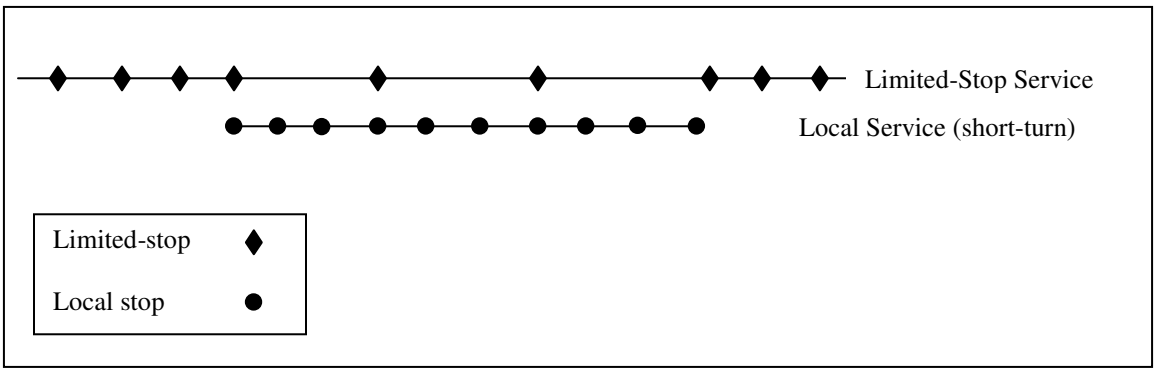


FIGURE 2: Limited-Stop with Local Service Overlay

As part of ongoing service adjustments, NYCT adjusts the frequency of bus routes based on the ridership on each route. As ridership increases on a route more service is typically added by increasing the frequency of service. Limited-stop service at NYCT is implemented on a route when the ridership increases sufficiently to support six minute headways throughout a time period. Often this headway threshold is only achieved during the peak period and sometimes only in the peak direction. In these scenarios limited-stop service would only be implemented during the peak period or only in the peak direction.

Generally, at NYCT new limited-stop service is implemented as a cost neutral service change, meaning that local resources are divided between the existing local and new limited-stop service. The six minute headway threshold is necessary so that neither the local nor the limited-stop service will have headways greater than twelve minutes. Following the implementation of limited-stop service ridership has generally increased overall on the route, typically with limited-stop ridership growth outpacing local ridership growth, as evidenced by the NYCT bus schedules which are adjusted based on ridership. As ridership has increased on limited-stop routes service was more likely to be added to the limited-stop service, resulting in some limited-stop routes running at a 2:1 ratio to local service and sometimes even 3:1.

Limited-Stop Service Effectiveness

Limited-stop service has resulted in significant travel time savings as compared to its local counterpart. Route level running time reductions as compared to a parallel local service range from 10% in Staten Island up to 15% in the Bronx. Listed in descending order by travel time savings the average savings by borough are:

- The Bronx: 15%
- Queens: 14%
- Manhattan: 12%
- Brooklyn: 12%
- Staten Island: 10%

The primary purpose of limited-stop service is to improve service on high ridership corridors while controlling cost increases. In some cases travel time savings are enough that a full headway can be saved which allows for service to be added at no additional cost. Furthermore, limited-stop service has helped retain ridership on some limited-stop routes and has also reduced overall bunching on these routes (1).

Customer Perceptions

NYCT conducts surveys before and after implementation of limited-stop routes and customer response has been consistently and overwhelmingly favorable. Some previous NYCT studies have shown that customers perceive the travel time savings to be twice as much as the actual savings (1). An initially surprising but consistent finding is an increase in customer satisfaction for both local customers and limited-stop customers. Further research found that even occasional use of limited-stop service is sufficient to produce overall positive impressions among local customers (Figure 3).

4 TIMEPOINT REMOVAL AT NYCT

Like most transit systems NYCT utilizes intermediate timepoints on bus routes as a control strategy in an effort to keep buses running on time. Each bus operator is provided with a list of specific stops along his or her route and the times that he/she is supposed to reach each of these stops. These times are based on the scheduled running time and the stops are referred to as intermediate timepoints. Operators are instructed to wait at these stops if they arrive ahead of schedule or slow down prior to the stop if it appears that they will reach the stop early. This strategy is supposed to help keep buses on schedule but also has the unfortunate tendency to annoy customers who are already on board the bus. Furthermore, while it reduces waiting time by increasing reliability it also increases in-vehicle time. Therefore NYCT first experimented with removing these timepoints on the Bx12/SBS12.

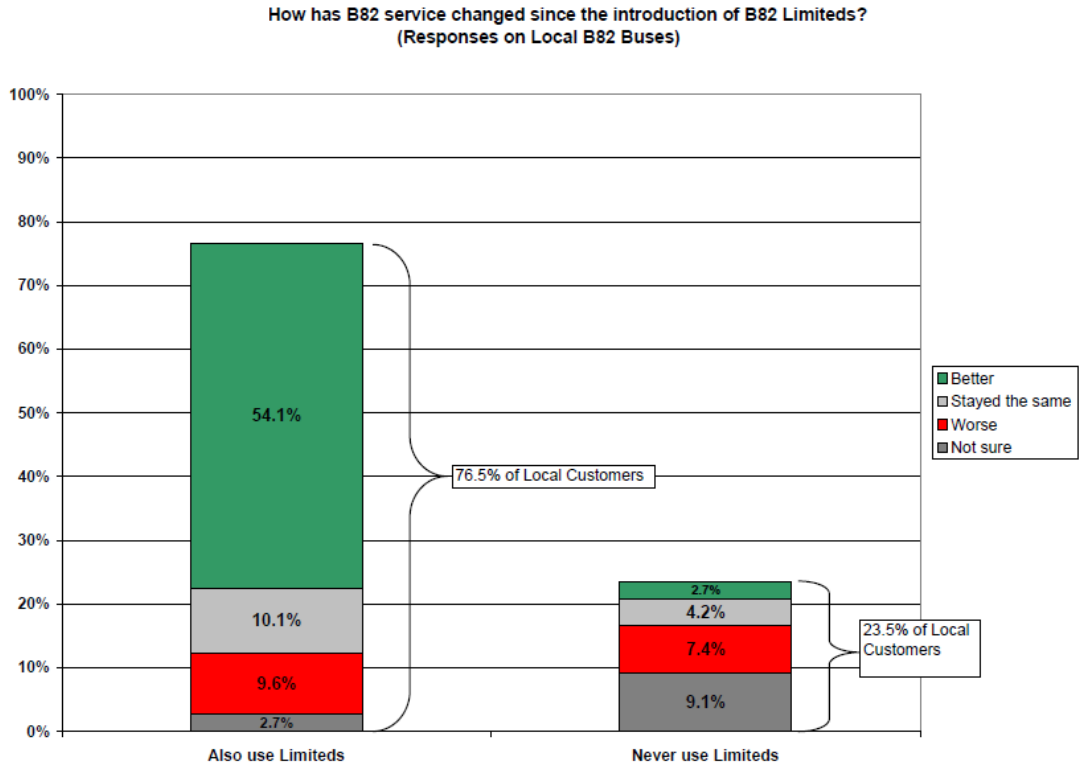
Bx12/ SBS 12 Timepoint Removal Precedent

The first route at NYCT to run without intermediate timepoints was the Bx12 Select Bus Service (SBS) route in the Bronx, which was also the first SBS route (Figure 1 above). Select Bus Service is NYCT's version of Bus Rapid Transit (BRT) and has the following features:

- No intermediate timepoints
- Off-board fare collection and all door boarding
- Signal priority and/or an enforced dedicated bus lane along some parts of the route
- Branding

The primary purpose of SBS is to reduce travel time. NYCT studies on SBS routes have shown a 20% decrease in travel time. Most of this travel time reduction was a result of the various features of BRT, but some of this reduction may be a result of the removal of intermediate timepoints.

Following the removal of intermediate timepoints on SBS routes, timepoints were also removed on the M34 crosstown (Figure 1 above) and on the SBS 15 (M15) in Manhattan. Both of these routes have other travel time reducing features including dedicated bus lanes on the M34 and off-board fare collection and signal priority on the M15. Thus the effects of intermediate timepoint removal could not be studied in isolation. However, once the timepoint removal precedent had been set and proven successful on the SBS routes and on the M34, NYCT implemented a pilot program to remove intermediate timepoints on additional limited-stop routes. The primary purpose of this pilot was to study the effects of this strategy in isolation from other features.



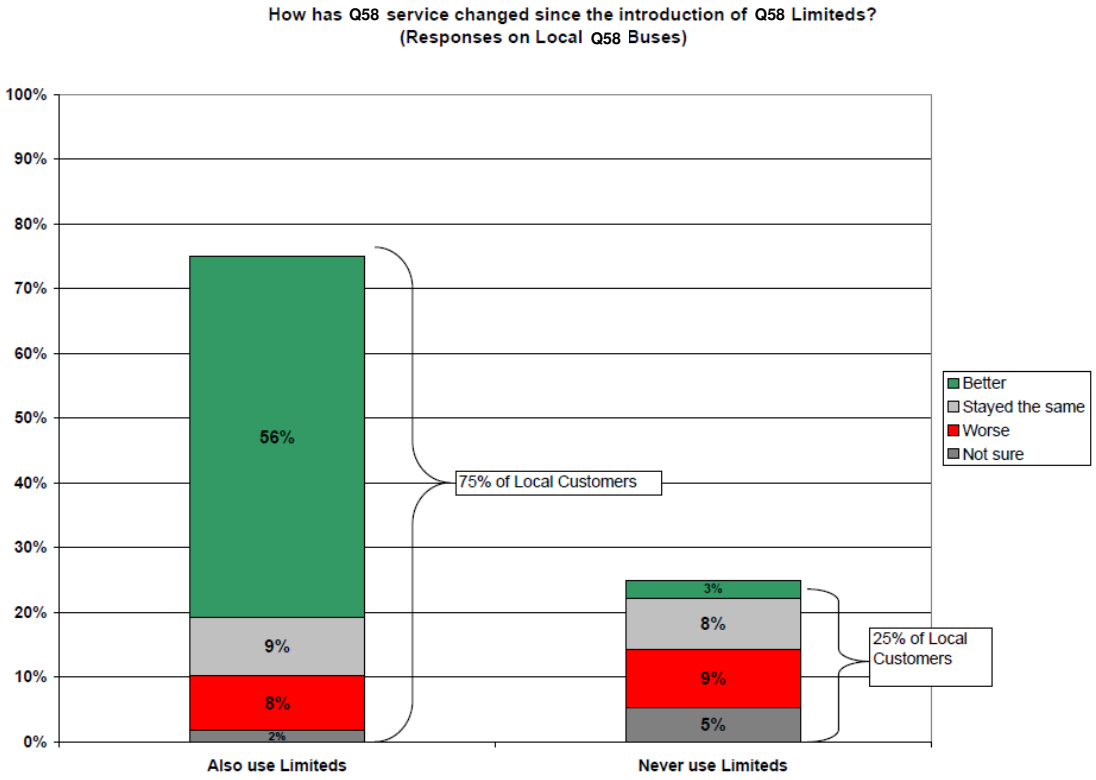


FIGURE 3: Local Service Customer Perceptions Following Limited-Stop Implementation
MTA New York City Transit B82 Limited-Stop Study (unpublished data),
MTA New York City Transit Q58 Limited-Stop Study (unpublished data)

As of August 2011 there were a total of 10 routes that ran without intermediate timepoints (Figure 1 above, Table 2). NYCT removed intermediate timepoints from seven limited-stop routes in addition to the SBS routes and the M34. On two routes (B82, Q58) limited-stop service was implemented along with timepoint removal so the effects of timepoint removal could not be isolated, which meant that these routes were not good case studies. Five routes already had limited-stop service and the only change was to remove intermediate timepoints; four of the five (B6, B35, Q17, and Q43) are typical NYCT limited-stop routes and were thus good case studies for studying the effects of timepoint removal in isolation from any other time saving features. The M98 (the fifth of these routes) was not a good case study since it operates more like an express bus than a limited-stop route.

TABLE 2

Intermediate Timepoint Removal at NYCT: 10 Bus Routes	
As part of Select Bus Service (SBS) ▪ Bx12, M15	On existing limited-stop routes ▪ B6, B35, Q17, Q43, M98
With dedicated bus lane ▪ M34	On new limited-stop routes ▪ B82, Q58

5 METHODOLOGY

A frequent complaint that NYCT hears from its customers is that operators drive slowly or stop at green lights to hold to timepoints, which is especially annoying to limited-stop customers who tend to be more interested in faster service than are local customers. With that in mind and based on the success of the SBS routes NYCT implemented a pilot program to remove intermediate timepoints on some limited-stop routes. The pilot program began officially with the removal of timepoints on the B35 and Q43 during the spring of 2010.

NYCT removed all intermediate timepoints (except at short-turn points and relief points) from the schedules of limited-stop pilot program routes. Bus operators were instructed not to hold at these timepoints except at relief points on trips with a relief. A relief point is a location somewhere between the beginning and end of the route where there is a scheduled change in bus operator on a particular trip; only some trips have a relief. Bus operators were also instructed to pass their leader (the bus scheduled to be ahead of them) if their leader was boarding a wheelchair or delayed for any reason. Furthermore, dispatchers were asked to break up bunching if necessary. Local service on the same corridor retained all timepoints. NYCT did not inform customers of these changes.

Goals and Expectations

The goals of the pilot program were to:

- Eliminate holding at green lights and unnecessary holding for schedule adjustments
- Reduce running times and shorten customer trips
- Improve customer satisfaction due to reduced travel time

In general the pilot was expected to have an overall positive effect; however, one possible downside was the impact on reliability. The purpose of intermediate timepoints is to keep trips

on schedule and without these timepoints it was possible that reliability would decrease. This potential negative effect was evaluated in the pilot study.

Coordination

Planning for the pilot was conducted by the Bus Planning Unit of Operations Planning in coordination with several units and departments:

- Schedules Unit of Operations Planning: made the adjustments to the schedules to remove the timepoints
- Systems, Data and Research Unit of Operations Planning: to ensure that data would be available to analyze the impacts of the pilot program
- Marketing Department: to address the impact on the formatting of timetables which provide customer information on each bus route including maps and schedules. Removing timepoints from the limited-stop service but not the local was problematic for the formatting of timetables since timepoints appear on timetables. The Marketing Department also developed before and after surveys of customer perceptions and satisfaction

Measures of Effectiveness

There are three measures of effectiveness that were used to evaluate the pilot program and will be the focus in this paper:

- ***Travel time*** based on running times obtained from ridechecks or point checks.
- ***Headway regularity*** based on the wait assessment data.
- ***Customer satisfaction*** based on customer satisfaction surveys.

Data Availability and Analysis

The data used in this paper is based on point checks, ride checks, automatic fare collection (Metrocard) data, and customer satisfaction surveys. Since NYCT does not have Automatic Vehicle Location (AVL) or Automated Passenger Counters (APC), the data available to evaluate the pilot program is primarily manually collected data and in most cases is limited to one or two full days of manually collected ride checks or point checks conducted before and after the timepoint removal. Ride check data is collected by a person riding the bus the full length of the route and noting boardings, alightings, and times at each stop. Point check data is collected by a person at a timepoint from outside the bus observing buses pass by and recording passenger loads and times. A complete set of point checks or ride checks includes every trip on a route for an entire day. Metrocard is NYCT's farecard system; with respect to data it is most useful for route level ridership data. Currently, Metrocard is not connected to an AVL system so it cannot provide running time or reliability data.

Analysis is also based on Wait Assessment data which is collected through manual point checks several times a month to produce statistically significant results for on-time performance and headway variability. It is thus more robust with respect to estimated passenger wait time than typical NYCT point checks or ride checks which are only collected once every few years. Unfortunately wait assessment data is only collected for routes that are deemed to have chronic on-time performance issues and not all routes, and is only available for three of the pilot routes. Wait assessment is a measure of headway variability: it is measured weekdays between 7:00 a.m. and midnight. It is defined as the percentage of observed service intervals (headways) that are no more than the scheduled interval plus 3 minutes during peak (7 a.m. – 9 a.m., 4 p.m. – 7 p.m.) and plus 5 minutes during off-peak (9 a.m. – 4 p.m., 7 p.m. – 12 a.m.).

Customer Satisfaction surveys are conducted by the Market Research Department and are conducted on board buses on predetermined days, times, and sample sizes. Customers are randomly selected on board buses during the day/time selected and questions are read to the customer with the customer verbally responding. The person administering the survey records the customer answers and the results are later compiled and analyzed.

Ridership

The effect on ridership is only briefly touched on in this paper. NYCT experienced declining ridership during 2010 and 2011 across the system and especially during the winter of 2011 which was unusually cold and snowy and contributed to lower year to date averages. This made it difficult to determine the impact of the pilot program on ridership and no consistent trend was identified. The only exception is that ridership data was used to compare the before and after limited-stop vs. local ridership split and bus loads to evaluate the impact on local service.

Challenges

The lack of real time AVL data at NYCT makes real time control of bus routes more difficult. One of the expectations of the pilot program was that Road Operations would be able to break up bunching and in general make adjustments for very long or short headways. However, given that road operations has very limited resources and only manually transmitted data available with which to make decisions, this was not possible to the extent that the pilot assumed. In general, limited-stop buses ran with very little intervention by road operations.

Ideally, analysis would have been conducted at a more detailed level to evaluate running time and especially reliability by time period at the timepoint level. However, due to a lack of robust detailed data as could be obtained from an AVL system the data available was not sufficient to conduct this more detailed analysis. The analysis and conclusions in this paper are based on more aggregate data, at the route level by direction. However, this was sufficient to draw some conclusions to evaluate the pilot program.

There was some understandable skepticism about the pilot program and concerns were raised by some departments about safety. One concern raised was that operators would drive recklessly fast without the timepoints to slow them down. In most boroughs these concerns were ultimately overcome and the pilot program proceeded. Anecdotally Operations Planning has not heard reports of reckless driving.

No changes were made to the local service, but since local and limited-stop service operate on the same corridor and share a ridership base; changes to the limited-stop service can affect parallel local service. A concern raised with respect to local service was that the limited-stop service might become less reliable once timepoints were removed and that this would result in a shift of passengers from the limited-stop to the local service, which could cause local service travel times to increase due to longer dwell times. In general, ridership analysis has not been included in this paper for the reasons described earlier; however, ridership analysis was conducted for some local routes, specifically an analysis of the limited-stop and local ridership split before and after timepoint removal.

6 CASE STUDY RESULTS

Data on running time, service reliability, and customer satisfaction was collected before and after implementation of the pilot program. This section provides the results of the data analysis for the

pilot routes (Table 3). For each route the results of the limited-stop service analysis are presented. Local service analysis is also presented for two of the case studies (B35, Q43).

TABLE 3: Route Statistics for the Case Studies

	B35	**Q43**	**B6**	**Q17**
Borough, Route Type	Brooklyn, Crosstown	Queens, Subway Feeder	Brooklyn, Crosstown	Queens, North/South
Average Weekday Ridership	37,000	16,000	43,000	19,000
Local Service Span	24/7	24/7	24/7	24/7
LTD Service Span	7 days, Except overnight	Peak hrs, Peak direction	6 days, except Sunday and overnight	Peak hours
One-way Route Length/ Limited Segment Length	6.8 miles / 4.1 miles	6.8 miles / 6.8 miles	10.8 miles/ 4.8 miles	7.0 miles/ 7.0 miles
One-way AM Peak Average running time (Before timepoint removal)	64 minutes	43 minutes	85 minutes	45 minutes
Local AM Peak Headway	6 minutes	4 minutes	9 minutes	7 minutes
LTD AM Peak Headway	5 minutes	4 minutes	6 minutes	11 minutes
LTD Implementation	Summer 2005	Winter 1993	Fall 2000	Fall 2003
Timepoint Removal	Spring 2010	Spring 2010	Winter 2011	Winter 2011

B35 Analysis

B35 Limited-Stop Service Analysis

- **Travel Time Impact**: Based on two days of ride checks before and after timepoint removal, there was an average of about 3 minutes of travel time savings westbound and 1 minute eastbound on the limited stop portion of the route.

- **Reliability**: The wait assessment data showed that reliability slightly decreased. Prior to timepoint removal 86% of trips were within the acceptable range, while 84% met this standard after timepoint removal. The "before" period covered two years of data from April 2008 through March 2010. The "after" period covered the period from the beginning of the implementation in April 2010 through March 2012.

- **Customer Satisfaction**: The MTA New York City Transit Limited-Stop B35 and Q43 Bus Holding Study (6/8/2010), a customer satisfaction survey and internal report, found that B35 limited-stop customers perceived that the ride was faster and that there was less holding at green lights after time point removal as compared to before timepoint removal. Customers were asked if they noticed buses slowing down when approaching green

signals, which is a method bus operators often use if they are approaching a timepoint too early. B35 limited-stop customer perception changed dramatically with respect to green light holding with far fewer customers saying that buses slow down for green signals, while their perception of wait time did not change. This would imply that service reliability was not perceptibly altered. The B35 customer survey had the most definitive result of the pilot routes.

B35 Local Service Analysis

- **Travel Time Impact**: Based on an analysis of running time data from point checks, local B35 service appeared to be on or ahead of schedule. In the westbound direction trips were about 2 minutes ahead of schedule, while trips were on schedule eastbound. Therefore, it can be concluded that timepoint removal on the B35 limited-stop service did not increase running times on the local service. It is unclear why local trips were operating ahead of schedule following timepoint removal on the limited-stop service. In most cases the bus operators who drive the local route also drive the limited-stop route. Thus, one possible explanation for the reduced local travel time is that bus operators have become accustomed to operating faster on the limited-stop route and not being constrained by time points and that this is carrying over into how they operate on the local route. Further analysis would be needed to support this hypothesis.

- **Reliability:** The wait assessment data showed that reliability decreased on local service following timepoint removal. Prior to timepoint removal 85% of trips were within the acceptable range, while only 82% met this standard after timepoint removal. However, since local trips were running ahead of schedule this degradation in reliability would not appear to be a result of the limited-stop timepoint removal, or at least not consistent with the hypothesis that customers would shift to the local and thus slow it down. This reduction in reliability is more likely related to the increased number of trips that were operating ahead of schedule and not adhering to timepoints while other trips did adhere to timepoints. Inconsistent operator behavior can result in erratic headways and reduced reliability.

  Another possible explanation is an increase in missed trips across the NYCT bus system during the period of analysis. During the study period the percent of trips that were filled as compared to prior years fell by over 1%, from 99% to under 98%, which may seem like a small decrease but a 1% decrease can in fact have a significant impact on reliability. Increased missed trips would result in a higher percentage of long headways and thus reduced reliability. The fact that limited-stop service reliability was not impacted as significantly as the local service may imply that fewer limited-stop trips were missed as compared to local trips, or alternatively might imply that timepoint removal prevented the limited-stop service reliability from degrading as much as the local service. Further study would be necessary to determine the true cause.

- **Ridership**: based on Metrocard data limited-stop ridership on the B35 as a percent of total B35 ridership remained roughly the same only increasing slightly to 28% after timepoint removal from 27% before. In addition, an analysis of average bus loads from the before/after pointchecks found that limited-stop trips had equal to higher loads versus local trips in both the before and after case. Therefore, there does not appear to have been a significant customer shift between local and limited-stop service, and if there was a shift it was towards limited-stop service.

Based on this analysis it can be concluded that removing timepoints on the limited-stop service does not appear to have been the cause of the degradation in reliability observed on the local service.

Q43 Analysis

Q43 Limited-Stop Service Analysis

- **Travel Time Impact:** Q43 limited-stop service operates only during peak hours in the peak direction. Following timepoint removal there was an average travel time savings of 2 to 3 minutes in each direction.

- **Wait Assessment:** The percent of trips within an acceptable range after implementation was 91%, which is higher than the 88% of trips that met this standard before implementation. The "before" period covered two years of data from April 2008 through March 2010. The "after" period covered the period from the beginning of the implementation in April 2010 through March 2012. These results show that reliability improved following timepoint removal. It is unclear whether this improvement is the result of the timepoint removal or if there are other factors. However, it can be concluded that timepoint removal did not adversely affect reliability on the Q43 limited-stop service.

- **Customer Satisfaction:** The MTA New York City Transit Limited-Stop B35 and Q43 Bus Holding Study (6/8/2010), a customer satisfaction survey and internal report found that there was a large increase in the percentage of Q43 customers who felt that the speed of their ride improved but there was no statistically significant change in overall customer satisfaction.

Q43 Local Service Analysis

Local service travel time and reliability were not analyzed for the Q43.

B6 Analysis

B6 Limited-Stop Service Analysis

- **Travel Time Impact:** Based on an analysis of point check data, travel time savings in both the eastbound and westbound direction averaged about 1 minute.

- **Wait Assessment:** The wait assessment data showed that reliability stayed the same. Before and after timepoint removal 83% of trips were within the acceptable range. The "before" period covered data from January 2009 through December of 2010. The "after" period covered the period from the beginning of the implementation in January 2011 through March 2012.

- **Customer Satisfaction:** The MTA New York City Transit Limited-Stop B6 and Q17 Bus Holding Study (6/1/2011), a customer satisfaction survey and internal report, found that as compared to the before survey the after survey showed both local and limited-stop customers had a significantly more favorable impressions of B6 service after timepoint removal. Both local and limited-stop overall customer satisfaction remained high. With respect to several questions related to travel time and holding a large percentage of

customers thought that the speed of their trip had gotten better. In addition, far fewer local and limited-stop customers thought that buses sometimes sit at bus stops for long periods for no apparent reason and that buses sometimes slow down when approaching green traffic signals. There was no statistically significant difference between limited-stop customer perceptions and those of local customers. However, previous NYCT studies have shown that even occasional use of limited-stop buses by local customers can produce overall improved perceptions of both the local and the limited-stop service. Therefore, it is possible that these improved customer perceptions on both the local and limited-stop service are a reflection of the faster running times on the limited-stop service. Furthermore, local service analysis (discussed next) found that local trips were running faster after timepoint removal while reliability remained about the same. This may also explain the increased customer satisfaction on the local service.

B6 Local Service Analysis

- **Travel Time Impact**: Based on point check data local B6 trips were operating on schedule following timepoint removal on the limited-stop. This compares with 4 minutes longer than scheduled before timepoint removal. Therefore, it can be concluded that timepoint removal on the B6 limited-stop service did not adversely affect running times on the local service. Furthermore, during field visits conducted by Service Planning many trips were observed to be running ahead of schedule. In most cases the bus operators who drive the local route also drive the limited-stop route, so one possible explanation for the reduced local travel time is that bus operators have become accustomed to operating faster on the limited-stop route and this is carrying over into how they operate on the local route. Further analysis would be needed to support this hypothesis.

- **Reliability:** The wait assessment data showed that reliability stayed the same on the local service. Both before and after timepoint removal 84% of local trips were within the acceptable range. Since the Q17 has a longer headway than some of the other case studies, reliability was potentially more of a concern.

- **Ridership**: limited-stop ridership on the B6 as a percent of total B6 ridership remained roughly the same at 62% after timepoint removal from 61% before timepoint removal. Additionally, an analysis of average bus loads from before/after pointcheck data showed that limited-stop trips had equal to higher loads than local trips both before and after. Therefore, there does not appear to have been a significant customer shift between local and limited-stop service and if there was a shift it was towards limited-stop service.

Based on this analysis it can be concluded that removing timepoints on the limited-stop service does not appear to have had an adverse effect on B6 local running times or reliability, in fact running times on the B6 local service improved.

However, despite this seemingly positive impact of timepoint removal on running times, there was considerable pressure from the bus operator unions to reinstate all timepoints. As this analysis shows this does not appear to be beneficial to customers, but as a compromise two timepoints were reinstated at two key points along the route, and in the fall timepoints will be reinstated at the ends of the route where the limited-stop route makes all local stops. Unfortunately, this will likely eliminate any travel time savings gained from timepoint removal since operators will slow down so that they do not reach these timepoints ahead of schedule. NYCT will monitor the B6 and will evaluate the impact of this change on running time and/or on-time performance.

Q17

Q17 Limited-Stop Service Analysis

- **Travel Time Impact:** Limited-Stop travel time savings were 5 minutes in the southbound direction and 1 minute in the northbound direction. When limited-stop service was initially implemented it saved about 3 minutes in each direction, or 6% of the running time. Removing timepoints on this route saved an additional amount equal to that saved by the initial limited-stop service implementation.

- **Wait Assessment:** Wait assessment data was not collected for the Q17 so this data is not available. Wait assessment is only collected on routes that are considered to be problem routes with respect to on-time performance, and the Q17 was not deemed to be a problem on-time performance route.

- **Customer Satisfaction:** The MTA New York City Transit Limited-Stop B6 and Q17 Bus Holding Study (6/1/2011), a customer satisfaction survey and internal report found that as compared to the before survey after timepoint removal far fewer local and limited-stop customers thought that buses sometimes slow down when approaching green traffic signals.

Q17 Local Service Analysis

Local service travel time and reliability were not analyzed for the Q17.

7 SUMMARY, NEXT STEPS, AND FUTURE RESEARCH

Timepoint removal on limited-stop routes appears to have resulted in reduced travel time on most of the case study routes while reliability stayed roughly the same (Table 4) and customer satisfaction generally improved.

TABLE 4: Case Study Analysis Summary

Limited-Stop Routes	Running Time Savings (*avg one-way*)	Wait Assessment	Local/ Limited Stop Ridership Split	Customer Perceptions	Local Service Analysis
B35	2 minutes	Reduced 2%	No change in local/limited split	Improved overall on limited-stop service	Reduced travel time, reduction in reliability
Q43	2 minutes	Increased 3%	na	Noticed an improvement in trip speed	na
B6	1 minute	No change in reliability	No change in local/limited split	Limited-stop and local perceptions improved, noticed less holding	Reduced travel time, no change in reliability
Q17	3 minutes	Not available	na	Customers less likely to say buses slow down at green lights	na
*na: not applicable					

Next Steps

The next step following the completion of the pilot program should be to adjust the schedules for pilot routes to account for any reduction in travel time. In addition, the pilot should be expanded to other routes in the system and the results of the new and existing pilot routes should be monitored.

Future Research

Due to data limitations it was not possible to analyze running times and reliability at the timepoint level. This more detailed analysis would have provided more insight into the effects of timepoint removal. However, based on this NYCT experiment it appears that timepoint removal can be an effective strategy to reduce running time without negatively impacting reliability. An expansion of the pilot program to other NYCT routes and ideally more robust data would be needed to confirm this initial result. Furthermore, similar experiments at other transit systems that have automated data collection systems and thus more robust data would further assist in determining the impact of timepoint removal on limited-stop service.

8 CONCLUSIONS

Like most transit systems, NYCT utilizes intermediate timepoints on bus routes as a control strategy. This strategy helps to keep buses on schedule but also tends to annoy customers who are already on board the bus. To address this issue New York City Transit began a pilot program in the spring of 2010 to remove intermediate timepoints from the schedules of limited stop routes with the goal of reducing travel time. This paper reviewed the experience and findings of NYCT with respect to this pilot program including before and after measures of effectiveness: running time, headway regularity, customer perceptions, and in some cases the ridership split between the limited-stop and local service.

There were several key findings of this study. Timepoint removal from limited-stop service resulted in reduced travel time for all of the case studies, but very slight if any change in reliability, while customer perceptions generally improved. While no changes were made to local service, a concern raised prior to the pilot program was that timepoint removal would result in reduced reliability on the limited-stop routes which might result in a passenger shift to the local service and increased travel time on the local route. For the local routes that were analyzed (B35, B6) there was actually a decrease in travel time which is contrary to this hypothesis. There was a reduction in reliability on the local B35, but due to the reduction in travel time and no observed shifting of customers this did not appear to be an effect of limited-stop service timepoint removal.

Unfortunately, despite these positive findings and apparent customer benefits, there was considerable pressure from the bus operator unions to reinstate all timepoints. As a compromise timepoints will be reinstated on portions of the B6 route.

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