

Silver Line (Line 910) All Door Boarding Pilot Project Evaluation

Objective

In March 2016, Metro's Board of Directors (Board) approved the implementation of All Door Boarding (ADB) as a 6 month pilot project on the Silver Line. The purpose of the pilot, which began in June 2016, is to test a methodology for implementing ADB that increases speed and reliability of bus service, while controlling fare evasion. This service enhancement is part of Metro's continuing efforts to improve and enhance the transit experience and support Metro's Countywide Bus Rapid Transit (BRT) expansion.

Optimization of the Customer Transit Experience

The Federal Transit Administration (FTA) identifies a number of major elements critical to the success of BRT, such as type of running way, branding, stations, and Intelligent Transportation Systems (ITS). The incorporation of these elements achieves several key BRT objectives, including travel time savings, improved reliability, branding to attract new markets, enhanced safety and security, enhanced capacity, and accessibility.

The Silver Line (Line 910) is one of Metro's busiest bus lines, with an average of over 16,000 boardings per weekday, and growing. The line is challenged by poor on time performance as a result of heavy traffic along the I-10/I-110 ExpressLanes, which negatively impacts bus running times. High passenger boarding activity also results in lengthy dwell times at key stations, further impacting travel time and reliability.

The Silver Line has been a BRT "work in progress" over the past seven years. The line was first implemented in December 2009 by consolidating five distinct existing express lines into one consolidated line operating between Harbor/Gateway Transit Center and El Monte Station via the I-10 and I-110 freeways. Initially, the service was implemented with few BRT elements other than High Occupant Vehicle lanes and in-line freeway stations. However, with the implementation of Metro's ExpressLanes along the I-10/I-110 beginning in 2010, several infrastructure improvements were made, including:

- Redesigned and expanded El Monte Station;
- Sheriff substation at Harbor/Gateway Transit Center;
- Lighting and sound enclosure improvements;
- Improved local bus connections at Manchester and Slauson Stations;
- Improved signage and wayfinding;
- New branded buses;
- Signal priority and extended bus only lanes in downtown Los Angeles;
- Additional service frequency.

Today, the Silver Line incorporates six (6) key BRT attributes, which have contributed to the line's success (Table 1).

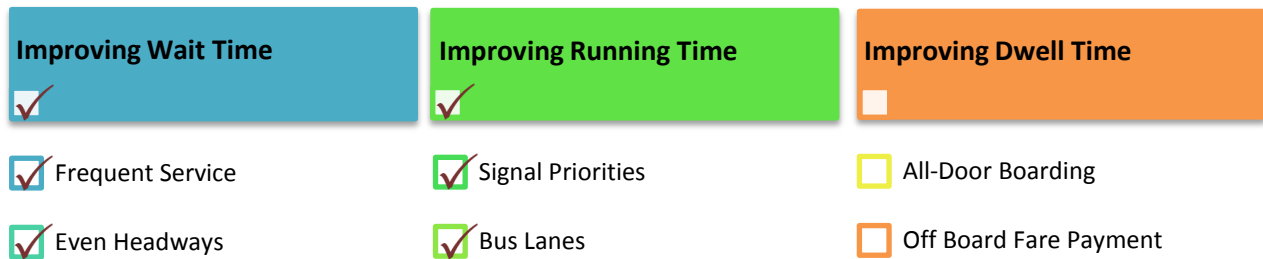
**Table 1
Attributes of BRT**

Element	Silver Line (Line 910)
Running Ways	<ul style="list-style-type: none"> High Occupancy Toll lanes along I-10 and I-110
Stations	<ul style="list-style-type: none"> In Line freeway stations with passenger amenities
Vehicles	<ul style="list-style-type: none"> Low floor buses
ITS	<ul style="list-style-type: none"> Arterial bus signal priority and NextBus technology
Service and Operations Plan	<ul style="list-style-type: none"> Frequent service with longer stop spacing
Branding Elements	<ul style="list-style-type: none"> Branded bus color and stop designation
Fare Collection	N/A

While the infrastructure improvements allow buses to operate at higher speeds through the congested corridors, excessive dwell times continue to impact the line’s performance due to high levels of boarding activity at key stops. As such, additional measures need to be taken to reduce travel time and improve reliability on this line.

Reducing customers’ transit travel time requires improvements to three parts of their trip: wait time, in service running time and stop dwell time. Figure 1 below summarizes the aspects of travel time and the optimizing strategies used to address them.

**Figure 1
Travel Time Strategies**



As other efforts are underway to reduce wait time and increase operating speeds, as indicated above, the ADB pilot program tests the effectiveness of the remaining element of BRT, faster boarding through more efficient fare collection. It is aimed at reducing bus stop dwell times and variability, by allowing customers with valid TAP cards to enter from the rear door. Cash and transfer customers are still required to enter through the front door.

Pilot Logistics

The Silver Line ADB pilot commenced on June 26, 2016. To expedite fare payment and allow for boarding at any door, Bus Mobile TAP Validators (BMV) were installed inside the rear door of all Silver Line buses. In addition, BMVs were installed on the left stanchion immediately inside the front door to allow customers with valid TAP cards to bypass any ongoing activity at the farebox. Customers without valid TAP fare payment or needing assistance continue to enter through the front door to interact with the operator.

One drawback to allowing customers to board through the rear door is the potential for inducing fare evasion. To minimize this issue, the ADB pilot was implemented with the requirement that customers need to have a validated TAP card when riding the Silver Line. This allows for more thorough fare checks by enforcement officers, similar to the Metro rail system and the Orange Line.

Limiting fare payment to TAP only constitutes a fare change pursuant to Metro Administrative Code (Section 2-50-015). A Title VI analysis and a public hearing are required for any fare change that extends beyond the six month pilot period. A Title VI analysis was thus conducted to assess the impact of this fare change on minority and low-income/impoverished populations within Metro's ridership. The findings of the analysis were as follows:

- There would be no Disparate Impact to Minorities by limiting fare payment to TAP only;
- There would be a Disproportionate Burden on low income riders who currently use tokens to pay their fare.

To mitigate the issue of token as well as cash customers not being able to board without a TAP card, Metro staff took several significant measures to address this concern by implementing the following:

- Approximately 50,000 free TAP cards were assigned and distributed to passengers paying with cash and tokens on the Silver Line;
- Fareboxes were programmed with "reload" capabilities, allowing passengers to load stored value of up to \$20 onto TAP cards on board the bus;
- Ticket Vending Machines (TVM) are being installed at key stations, such as Harbor/Gateway and Cal State LA stops, with plans to install TVMs all in-line stations by Spring 2017;

A public hearing was conducted on October 19, 2016 to consider TAP only boardings as a condition of the Silver Line ADB project. Around 20 comments were received with the majority favoring the ADB pilot with TAP only boarding. As a result, the Board approved this fare change as a component of ADB on the Silver Line.

To mitigate fare evasion, two dedicated teams of LASD fare enforcement officers were assigned to address fare enforcement and quality of life issues on the Silver Line through the pilot period. Their mission is to provide safety and security under a high visibility deployment plan in which they enforce Metro's Customer Code of Conduct at stations and on board buses.

Communications and Customer Engagement

An important part of the process was engaging customers, to share project objectives and solicit their opinions on the value and viability of the project. Prior to commencing the pilot, an extensive public outreach campaign was conducted to educate passengers on the ADB pilot and the TAP only requirement, including the following:

- Teams of “Blue Shirt” ambassadors were stationed at major Silver Line stops for two weeks prior and one week after implementation to educate the public and assist in the transition to TAP only;
- 75,000 Take Ones were distributed in English, Spanish and Chinese on buses and at stations (Attachment B);
- New “Know Your Fare!” pamphlets were developed and 5,000 of them distributed on buses and at stops (Attachment B);
- 50,000 wallet-sized TAP hand-outs were developed to distribute with the free TAP cards to cash riders;
- Car cards were posted in all Silver Line buses;
- Pull up banners were deployed at major stops to help alert customers to the coming project;
- Customer refund cards were created and distributed to Operators to help resolve issues of lost payment at the farebox;
- Special map case advertisements were posted at the major stations; and
- Announcements of ADB and TAP only were posted on the Silver Line’s website and the Source/El Pasajero.

Staff also visited Operating Divisions that manage the Silver Line to solicit input from the Bus Operators. In addition, a comprehensive training program was developed to educate Silver Line operators on the TAP card “reload” process and ADB, including the following:

- Tariff Notices and Operator cheat sheet on ADB and TAP only fare payment;
- PowerPoint based training tool at the divisions;
- Mobile training farebox with “reload” capabilities at the divisions;
- RAP sessions with operators to exchange information and feedback;
- Division management briefings;
- Supervisor trainings (“Train the Trainer” sessions); and
- On street monitoring and operator assistance/support.

These outreach efforts had proven in the past a more effective way to ensure proper implementation of the project, and minimizes confusion on both the part of the Operator and the customer.

Scope of Evaluation/Evaluation Program/Evaluation Plan

While ADB can result in true dollar cost savings and revenue impacts, the perceived benefits and drawbacks of the program should be considered equally important in the evaluation, given its influence on service quality and ridership. Therefore, the scope of evaluation of the ADB pilot consists of:

- Calculated dwell time savings and its impact on resource requirement and service reliability;
- Estimated impact to fare evasion;
- Customer perceptions of the benefits and drawbacks of implementing ADB;
- Other lessons learned and field observations from the ADB pilot program.

To support the evaluation plan, quantitative data was collected during the test period, as well as qualitative assessments through surveys, focus groups and peer agency reviews, as follows:

- Automatic Passenger Counter (APC) boarding data;
- Farebox and Bus Mobile Validator (BMV) fare unit counts;
- On Time Performance data and field observations;
- Data from the Transit Court department regarding fare evasion;
- Customer surveys conducted by OMB and TAP staff; and
- Vehicle Operations Supervisors (VOS), TAP “Blue Shirt” ambassadors and Operator debriefs.

Findings

Dwell time data was collected from Automatic Passenger Counter information which includes time and location stamps for “door open” and “door close” activities. Data was analyzed for a baseline period (February 2016) prior to the ADB pilot, as well as during the ADB pilot (October 2016). The information was segmented by time of day and by Silver Line stops. Based on this information, the Silver Line ADB pilot demonstrated that there can be resource savings from a reduction in dwell time. In addition, reducing the range (or fluctuation) in dwell time from trip to trip helps to improve the line’s overall reliability and headway regularity.

Bus stop dwell time consists of a “fixed” and a “variable” component. All stops incur a minimum “fixed” amount of dwell time that represents the time between door open and the first customer activity, and the time between the last customer activity and door close. This amount of time generally appears to be around 10 seconds, but can vary depending on operator response time opening and closing the doors, and the speed of the first customer boarding or alighting the bus. Stops also incur a “variable” amount of dwell time depending on the amount of customer activity (number of boardings/alightings). ADB addresses the variable component of dwell time and not the fixed component. Therefore, ADB provides the greatest benefits at stops with high customer activities vs. low activity stops since the variable component is a greater percentage of overall dwell time at stops with high activity compared to stops with low activity (Figure 2). Table 2 shows a comparison of average station dwell times per boarding and alighting activities based on the amount of activity per trip.

Figure 2
Relationship of Customer Activity (Avg. Daily Boardings and Alightings) to Dwell Time Reduction

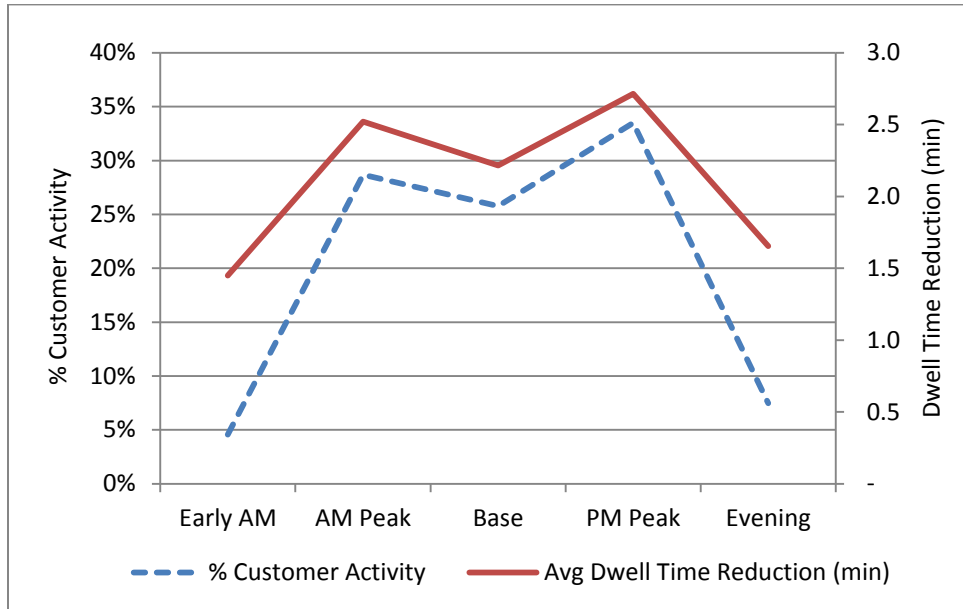


Table 2
Average Change in Dwell per Customer Boarding/Alighting

Avg. Boardings/Alightings per Customer	Seconds			
	Feb-16	Oct-16	Change (#)	Change (%)
Stops with 10 or less	12.0	11.0	(0.98)	-8%
Stops with 11-15	4.6	4.2	(0.44)	-9%
Stops with 16-20	6.6	3.6	(3.07)	-46%
Stops with greater than 20	5.1	2.8	(2.28)	-45%

In addition, dwell times are impacted by a number of internal and external factors. Internal factors include the ability for customers to efficiently board and alight, pay their fares, load and unload bicycles and wheelchairs, and operator behavior. External factors include signalized intersection at a nearside bus stop, traffic congestion, and other conflicting movements (e.g. right turn traffic or bikes) that prevent a bus from pulling away from the bus stop. The ADB pilot addresses several of the internal factors, but cannot mitigate the impacts of external factors. Therefore, some stops with more significant external factors, such as 7th/Flower and 7th/Figueroa showed less benefit from ADB despite heavy customer activity. As shown in Table 3, the 7th Street stops experienced much less of an ADB benefit compared to other stops with similar levels of customer activities.

Table 3
Impact of External Factors on Dwell Time Reduction

	Avg. Ons/ Offs per Trip	Dwell Time Reduction
7th/Figueroa, 7th/Flower	12	-3%
All other stops with similar activity	9	-11%

Based on the average customer activity at each stop throughout the day, and the dwell time reductions from Table 2, Table 4 shows the average minutes of dwell time reduction per trip on the Silver Line for different time periods. Prior to ADB, each Silver Line trip incurred about 14 min of dwell time on average. Overall, ADB reduced dwell times by 2.1 minutes per trip, or about 15%. The greatest benefits were achieved during the PM Peak in the southbound direction, with a savings of 3.4 min, while the least amount of savings was during the Early AM in the southbound direction. However, since resource (bus) savings can only be achieved if the dwell time savings is equal to greater than the headway (4.5 min in the AM Peak and 5.0 min in the PM Peak), ADB alone does not reduce the number of peak buses required to operate the Silver Line. However, due to increased travel time along the corridor, ADB can be attributed to eliminating the need to add an additional bus during the peak periods, which would cost \$150,000 annually.

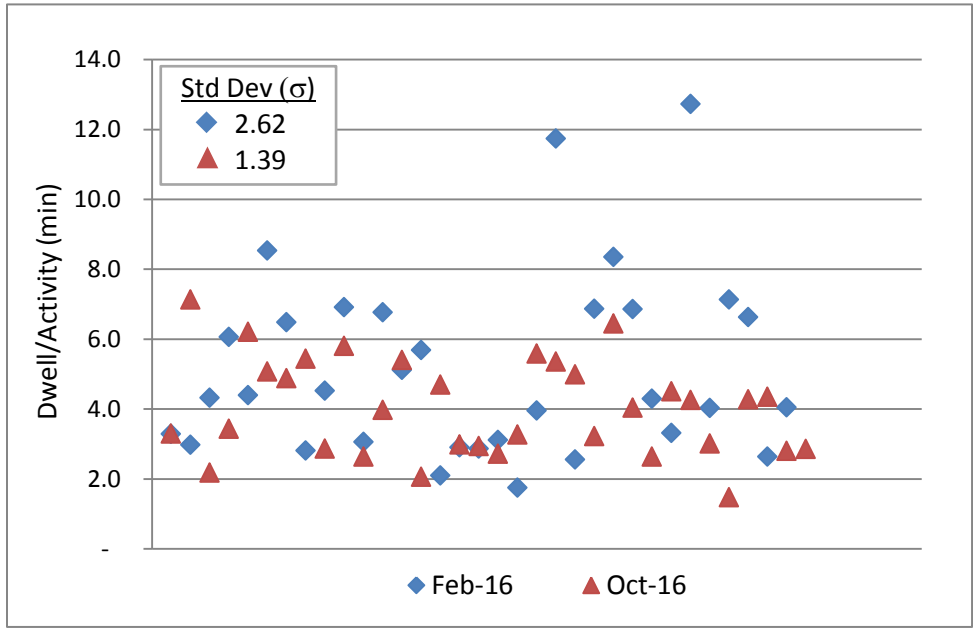
Table 4
Average Change in Dwell Time Per Trip

	Dwell Time Change (min)		
	Northbound	Southbound	Average
Early AM	(2.2)	(0.7)	(1.5)
AM Peak	(2.2)	(2.8)	(2.5)
Base	(2.1)	(2.3)	(2.2)
PM Peak	(2.0)	(3.4)	(2.7)
Evening	(1.1)	(2.2)	(1.7)
Average	(1.9)	(2.3)	(2.1)

ADB combined with planned ExpressLanes enforcement technology improvements should yield further travel time savings in the future. Additionally, current installation of TVM's at all in-line stations between El Monte Station and the Harbor Gateway Transit Center will reduce the amount of cash paying customer interactions at the farebox, thereby resulting in further ADB savings.

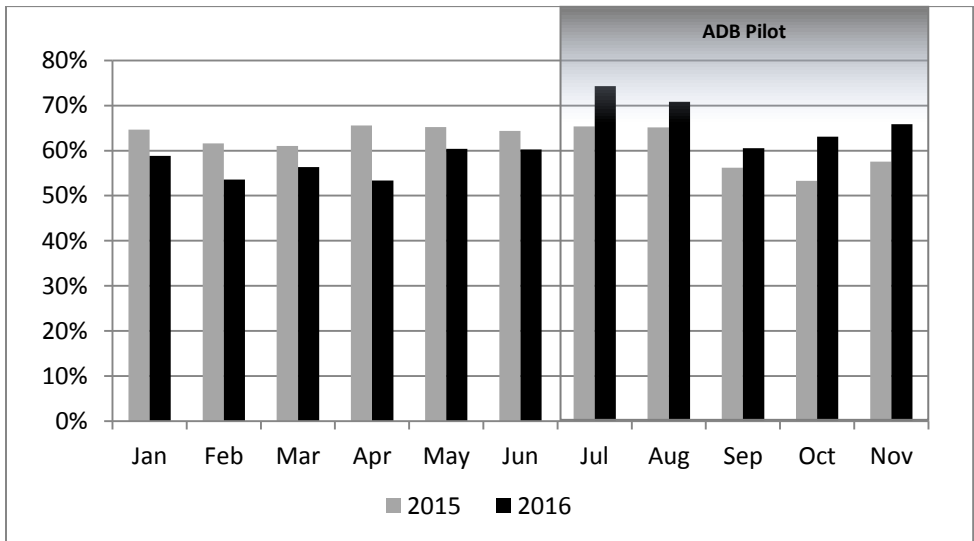
Although ADB did not save enough dwell time to achieve operational efficiencies, it did result in less fluctuation in dwell times at stops with heavy customer activity. Figure 3 shows the fluctuation in dwell times at stops with greater than 10 boardings/alightings. The standard deviation improved significantly from 2.62 to 1.39, meaning that dwell times were more closely aligned to the average after ADB compared to before.

Figure 3
 Fluctuation in Dwell Time for High Activity Stops (Greater than 10 Ons/Offs)



Since bus schedules are set once for every six month period, reducing fluctuations in both running time and dwell time should result in an improvement in On Time Performance (OTP). Figure 4 shows that OTP improved since the implementation of ADB as a result of 1) dwell time savings being reinvested into running time where needed, and 2) reduction in the fluctuation in dwell times, increasing the probability that schedules will be met. To achieve this improvement without ADB would require additional scheduled time to be added, likely resulting in increased resource requirement (and operating cost), as well as an overall increase in trip travel time.

Figure 4
 Silver Line In Service On Time Performance



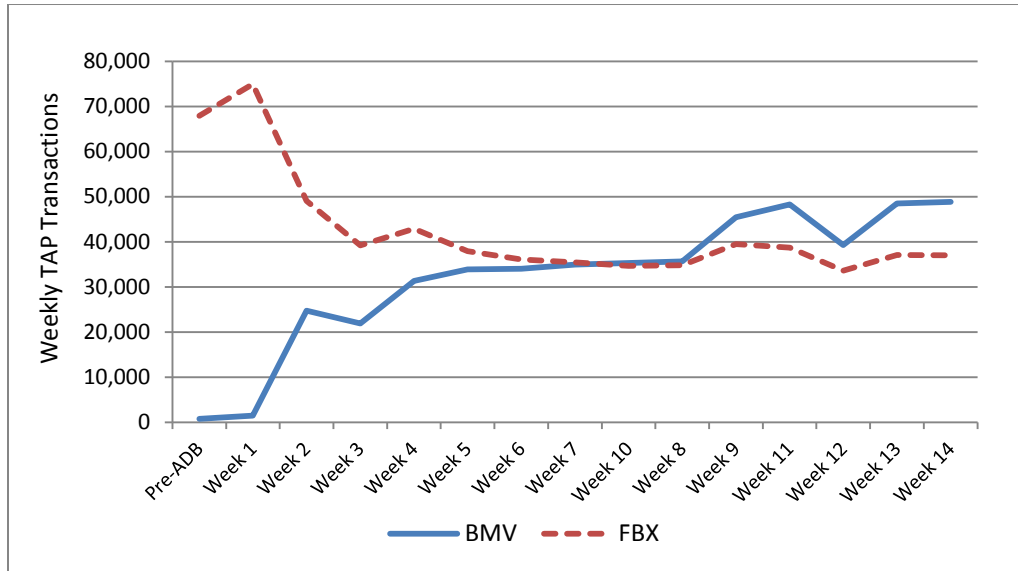
Access to all doors also means there may be a more even distribution of the passenger load, and less time would be spent boarding and sitting down on buses. As such, there can be less boarding-related safety hazards, fewer opportunities for customer injuries, and less delay before the operator departs from the stop.

Public and Employee Feedback

Feedback from the public, the operators and other involved staff was an important element of the project development and evaluation. Staff from the Office of Management and Budget (OMB), TAP and Operations Central Instruction (OCI) visited Divisions 9 and 18, which operate the Silver Line, and interacted with operators, training staff and law enforcement staff at information “RAP” sessions both before and after implementation. Divisional staff as well as the operators were interested and vested in the ADB project, and provided meaningful scenarios and suggestions for the project team to incorporate into the project planning. While there were some initial concerns about the way the project would work, collaboration through several meetings allowed the implementation team to adjust and mitigate possible challenges with the project. It also assisted the team with identifying the best way to share information between the operators and project team. There was also insightful feedback in meeting with the Los Angeles Sheriff Department (LASD) management staff, whose input helped to address issues with the process of fare enforcement.

The public provided feedback through customer service, the public hearing on TAP only fare payment, interaction with the Special Event Assistant (SEA) staff and members of the implementation team, as well as a customer survey. Customers quickly adjusted to the process of boarding through the back door, and only interacting with the operator when needed. Figure 5 provides a glimpse into the acceptance and use of the BMVs. Out of approximately 80,000 TAP transactions during a typical week, over 60% are now completed at the BMVs, compared to the first six weeks of implementation when the majority of TAPs were completed at the farebox. This confirms that passengers have become comfortable using the BMVs, with 81% of customers surveyed indicating that they have boarded through the back door, and of those, approximately 86% of them prefer to do so. Overall the customer feedback is positive, with 85.9% of customers surveyed indicating that the ADB project is a good idea and they are interested in seeing it continue.

Figure 5
 BMV vs. Farebox (FBX) Use



Fare Collection Management

One of the additional benefits of the ADB pilot is the requirement of a validated TAP card to board, which simplifies and automates fare collection. Additionally, it improves fare checking, which remains a challenge for most agencies implementing ADB.

Fare Enforcement Efforts

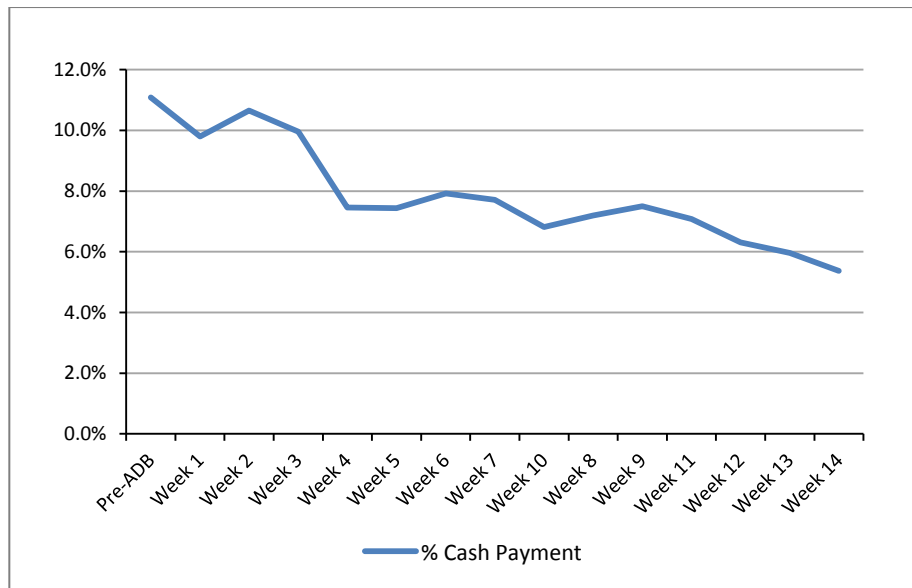
The perception of fare evasion is a concern for passengers who ride the Silver Line. Many passengers surveyed responded that they have seen fare evasion on numerous occasions. Fare evasion, whether real or perceived, continues to be the primary concern for agencies that have implemented ADB, and must be continuously checked and enforced to ensure that it does not escalate. The TAP only boardings policy has assisted in the reduction of fare evasion, and improves the ability to enforce fares, as there is no proof of payment issued for cash customers.

The Silver Line ADB pilot project was supported by one dedicated team of fare enforcement officers per AM and PM shift. Each team consisted of one Deputy and two Security Assistants. There were two teams scheduled per day, covering the AM and PM periods, Monday through Friday. Reports from the fare enforcement officers indicate that fare evasion has decreased from 8% in August to 5% in December 2016 as a result of the dedicated fare enforcement team, representing roughly \$125,000 in additional fare revenue per year. On average, citations were issued to 3-4% of customers found without proper fare payment.

Cash vs. TAP Usage

Transitioning more customers from cash to TAP boardings was an objective of the pilot as it reduces dwell times and improves fare enforcement. Figure 6 shows a steady decline in the number of fare payments using cash from June through early October 2016. As anticipated, there was a period of transition for passengers to change from using cash to using TAP cards. At present, the number of customers using cash is at a minimum, as there are still instances of customers who are either first time riders of the Silver Line, or are not interested in using TAP cards.

Figure 6
Percent of Payments Made on Silver Line Using Cash



In addition to TAP and cash, other fare media are still being used, including passengers who use tokens to pay for their trip, and paper transfers. However, efforts are underway to transition both of these fare products to TAP, which will improve the ability to enforce these fares.

Tables 5 and 6 compare the expected vs. actual cash fares collected on the Silver Line before and after ADB, February 2016 and October 2016, respectively.

Table 5
Silver Line Farebox Cash Fares (February 2016)

Cash Category	Boardings	Cash Fare	Total Cash		Difference in Total Cash	
			Expected	Actual	\$	%
Adult	35,550	\$2.50	\$88,875	\$79,772	-\$9,103	-10%
S/D	10,790	\$1.35	\$14,567	\$10,415	-\$4,151	-28%
Student	280	\$1.00	\$280	\$337	\$57	20%
Total	46,620	\$2.22	\$103,722	\$90,525	-\$13,197	-13%

Table 6
Silver Line Farebox Cash Fares (October 2016)

Cash Category	Boardings	Cash Fare	Total Cash		Difference in Total Cash	
			Expected	Actual	\$	%
Adult	22,241	\$2.50	\$55,603	\$47,914	-\$7,688	-14%
S/D	7,912	\$1.35	\$10,681	\$7,508	-\$3,173	-30%
Student	232	\$1.00	\$232	\$402	\$170	73%
Total	30,385	\$2.19	\$66,516	\$55,825	-\$10,691	-16%

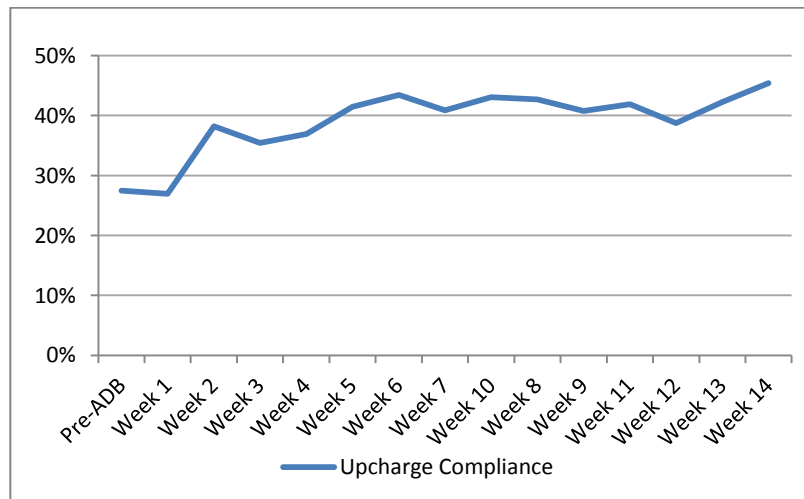
Overall, there was a decline in the number of customers paying cash, from 46,620 to 30,385, confirming that there has been a significant conversion from cash to TAP. However, there was a slight increase in the difference between actual and expected cash fare revenue. As a result, the average fare revenue per cash customer decreased from \$2.22 to \$2.19.

Upcharge Compliance

The Silver Line charges a premium fare of \$2.50 to ride, compared to the base adult cash fare of \$1.75. Therefore, customers are required to pay a \$0.75 upcharge if boarding using a free two hour transfer after paying \$1.75 in TAP stored value on a previous line, or with a regular 7-Day, 30-Day, or EZ TAP pass without zone upcharges. Given the uniqueness of the Silver Line fare structure, some customers were either not aware of the upcharge or unsure of when/how to pay it at the farebox.

Figure 7 shows the \$0.75 upcharge compliance by TAP passengers as a result of ADB. Through extensive operator and customer outreach and education, increased compliance has become another benefit of the pilot. Within a fifteen-week period, the upcharge compliance showed a steady increase, almost doubling. This improvement is expected to continue as the growing popularity of the BMVs will help ensure that the correct fare is automatically deducted from the TAP cards, unlike the farebox which requires manual interaction by the operator.

Figure 7
Percent Upcharge Compliance on the Silver Line



Recommendations

Based on the evaluation results, along with upcoming improvements to be implemented along the line, it is recommended that ADB continue on the Silver Line. While resource savings were not achieved during the six month pilot period, it is evident that the program has helped to improve on time performance by reducing fluctuations in dwell time and saving revenue hours to reinvest in running time. In addition, the TAP only boarding improved fare enforcement, upcharge compliance, and reduced dwell time.

Public and employee reaction to ADB has been favorable aside from the concerns about induced fare evasion. Therefore, the dedicated teams on fare enforcement officers must continue to support the Silver Line in order to ensure that fare evasion is monitored and punished, and public perception is addressed.

Future consideration to implement ADB on any other line should adhere to the following minimum requirements:

- **High Frequency** – In order to maximize resource savings the amount of dwell time saved must equal or exceed the scheduled headway. Therefore, any future candidate for ADB should maintain a peak hour average headway of less than 10 minutes.
- **Stop Activity** – The Silver Line pilot has shown that the maximum benefits of ADB are derived at stops with heavy customer activity. Therefore, new ADB lines should have more than 10 boardings and alightings per trip at stops that account for at least 50% of the trip's total boardings and alightings.
- **Transit Priorities** – To minimize the external factors influencing dwell time, any near side stop at a signalized intersection on a candidate line should have transit priorities. In addition, exclusive or partially exclusive Right of Way for the majority of the line is preferable.
- **Other Considerations** – Other factors that would improve the candidacy of a line for ADB include high wheelchair boardings, articulated buses, and a high percentage of cash paying customers.

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