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Mobility on Demand (MOD) Sandbox Demonstration: BART Integrated Carpool to Transit Access Program

Evaluation Report

FEBRUARY 2020

FTA Report No. 0156
Federal Transit Administration

PREPARED BY

ICF
Transportation Sustainability Research Center – UC Berkeley

U.S. Department of Transportation
Federal Transit Administration

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Courtesy of Bay Area Rapid Transit

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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liter	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C

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ABSTRACT

The Mobility on Demand (MOD) Sandbox Demonstration Program provides a venue through which integrated MOD concepts and solutions, supported through local partnerships, are demonstrated in real-world settings. For each of the 11 MOD Sandbox Demonstration projects, a MOD Sandbox Independent Evaluation was conducted that includes an analysis of project impacts from performance measures provided by the project partners and an assessment of the business models used. This document presents the Evaluation Report for the BART Integrated Carpool to Transit Access Program Sandbox project.

The project tested a number of hypotheses that explored the project impacts on carpooling, costs, enforcement, ridership, parking, and vehicle miles of travel (VMT). The evaluation generally found that the project increased overall carpooling to BART, commensurately increased the utilization of parking spaces by carpooling vehicles, and increased the number of people per vehicle parking at BART stations. The evaluation determined that the overall cost of enforcement per carpool space declined, primarily because spaces used for carpools increased without significantly increased enforcement burden. The evaluation did not have data available to determine if illegal use of carpool spaces had changed significantly as a result of the project. On the related matter of enforcement, the evaluation did not have data to quantify changes in fraudulent use of carpool spaces and, instead, relied on discussions with enforcement staff, which suggested that fraudulent use had dropped as a result of the project. The evaluation did find that the project produced a wider distribution of arrival times to carpool spaces, which was an objective of BART, to permit greater flexibility of travel times in the morning for carpooling riders.

The evaluation found that the project likely increased BART ridership, although not by margins large enough to be statistically noticeable within normal fluctuations of station ridership. Data were not available to determine whether this increase in ridership raised revenue that exceeded the costs of the project. However, users reported reduced personal transportation costs a result of the project. The project found that overall VMT very likely declined as result of the project due to the reduced driving alone to stations. Finally, expert interviews with project personnel produced lessons learned on implementation and policy that may inform similar projects in the future.

EXECUTIVE SUMMARY

This report presents the results of the independent evaluation of the Bay Area Rapid Transit (BART) Integrated Carpool to Transit Access Program, operated by BART and Scoop Technologies, Inc., (Scoop) with support from the Metropolitan Transportation Commission (MTC) and the Federal Transit Administration (FTA). The objective of the project was to improve carpool access to public transit by matching passengers with a transit station as their destination and to improve access to parking spaces at BART stations.

The BART Integrated Carpool to Transit Access Program was one of 11 Mobility on Demand (MOD) Sandbox Demonstrations partially funded by FTA. The independent evaluation was sponsored by the U.S. Department of Transportation (USDOT) Intelligent Transportation Systems Joint Program Office (ITS JPO) and FTA.

Demand for parking at BART stations is very high, as the majority of spaces fill by 8:00 AM each weekday. BART has a legacy carpool permitting program that provides dedicated carpool spaces at 21 BART stations. The program operates with first-come/first-served carpool spaces, but enforcement is challenging, and spaces are difficult to preserve for legitimate carpools. Hence, preventing fraudulent use of these spaces by single-occupancy vehicles (SOVs) requires live observation of passengers as they exit their vehicles, which ultimately is very staff-intensive and impractical given the resources and spatial spread of the BART system. As a result, BART does not provide dedicated carpool spaces at one third of its stations and has been reluctant to expand the number of spaces at stations at which the legacy carpool program exists.

The project aimed to address some of these challenges by using the Scoop carpool matching platform to match drivers and passengers with similar station destinations into carpools. The Scoop platform matches drivers and riders the night before a weekday morning commute and in the afternoon for the evening's commute. In Scoop's matching algorithm, drivers are allowed to pick up, at most, two riders along their trip. In the Scoop to BART program, the destination of the rider could differ from that of the driver, but the destination of at least one occupant must be a BART station. Drivers were given the incentive of a guaranteed parking space until 10:00 AM if they used Scoop to carpool to a BART station in the morning. The program also matched commuters for evening trips from BART to home.

The pilot program initially launched at the Dublin/Pleasanton BART station in January 2017 and expanded to 17 stations. The evaluation of the demonstration ended in April 2019, and the project ended shortly thereafter. This report explores the project through the evaluation of 13 hypotheses using survey data, Scoop activity data, citation data, ridership data, and expert (stakeholder/project partner) interviews.

Hypothesis 1: Carpooling to stations increases following the implementation of the Scoop to BART pilot project

The results of the evaluation revealed that Scoop was generally successful in increasing carpooling to the BART system, most notably the Dublin/Pleasanton station, which was a terminal point for 70% of the 115,806 carpool person-trips evaluated. The evaluation found that most Scoop activity connected to stations near termini of the BART system, including Warm Springs, Antioch, and Dublin/Pleasanton. The Orinda station, which precedes a major freeway tunnel bottleneck, was also a popular connection for Scoop trips.

Hypothesis 2: Utilization of parking spaces by carpooling vehicles increases

The Scoop to BART project generally succeeded in increasing the utilization of parking spaces by carpooling vehicles. The analysis found that 47,988 Scoop carpool vehicles had parked at participating stations between July 2017 and April 2019, with the Dublin/Pleasanton site accounting for 71% of this activity (note that this is the percent of all parked vehicles). System-wide, Scoop vehicles had 2.41 carpooling passenger trips for every vehicle parked. Although the magnitude varied by station, parking utilization by Scoop vehicles generally increased throughout the evaluation period. As a percent of all spaces, this utilization was generally low. The Dublin/Pleasanton station parking utilization by Scoop vehicles grew to about 4% by the end of the evaluation period. For most other stations, the parking utilization of Scoop vehicles remained under 1%. Only in Antioch did parking utilization by Scoop vehicles exceed 1% towards the end of the evaluation period. The evaluation estimated that Scoop increased the persons-per-parked-vehicle at the participating BART stations. This result could not be computed directly, as the overall occupancy of other vehicles using the lot was unknown. However, using assumptions, the analysis estimated upper bounds of changes in persons-per-parked-vehicle; by the end of the project, Scoop may have increased the persons-per-parked-vehicle by up to 5% at the Dublin/Pleasanton station and by about 1% at some other active stations such as Antioch, Warm Springs, and Orinda.

Hypothesis 3: The cost per enforcement per carpool space declined with no sacrifice in enforcement quality

The evaluation explored BART's cost of enforcement per carpool space, as Scoop had the ability to provide detailed information on who was carpooling each day. Due to data limitations, this had to be qualitatively assessed. BART felt that the additional marginal Scoop-specific enforcement activity added about one hour per week of labor, which amounted to an increase of about 0.3% of additional labor costs resulting from Scoop-specific enforcement.

Hypothesis 4: The number of instances of illegal carpool spaces per total carpool spaces available will be lower than before the pilot initiation

BART had sought a reduction in the number of instances of illegal carpool space citations as a result of the project. However, data on illegal carpool space use were not readily available. BART engages in monitoring carpool use and conducting enforcement of those spaces; violations are considered "permit" violations and are documented for enforcement purposes. However, documentation distinguishing permit violations related to carpool violations vs. other violations is subject to restricted access due to privacy consideration. To evaluate the hypothesis given these limitations, the evaluation team was provided data on general permit citations (without distinguishing the citation reason) for selected system stations at which Scoop was operating, including Warm Springs, Orinda, Dublin/Pleasanton, and Antioch, selected because they showed the highest Scoop usage. The data showed divergent trends of citations over time at the four stations, with citations increasing at three of the four stations. However, this was deemed to be due to increases in overall ridership activity, particularly since two of the stations recently opened. Ultimately, the analysis was inconclusive, as the data available could not permit a direct evaluation of carpool violations.

Hypothesis 5: The distribution of legal arrivals to carpool spaces will be closer to a uniform distribution between the hours of 6 am and 10 am than before the pilot

The evaluation of Scoop activity data found that Scoop enabled carpoolers to spread out their trip start times over the course of the project. The analysis found that whereas average start time shifted from 7:30 AM to 7:00 AM over the course of the project, the spread of start times increased across the hours of 6:00–10:00 AM . This meant that Scoop users took advantage of the greater flexibility provided by being able to park within the general permit parking lots.

Hypothesis 6: The number of persons per vehicle at BART stations increases after the program

Scoop data permitted analysis of carpooling activity with vehicles driven by system users. However, BART did not have data on overall parking at the station parking lots; as a result, a direct aggregate analysis of trends in persons per vehicle was not executable with existing data. However, the evaluation was completed with application of two assumptions that were strongly supported by the general knowledge of BART operations during this period. One assumption was that BART parking lots generally fill to capacity most weekdays. The second assumption was that the vast majority of vehicles in general parking were SOVs. Given these assumptions, the trends in Scoop activity shows that use of Scoop would have increased the persons per vehicle parked on the order of 5% at the Dublin/Pleasanton station, but by closer to 1% or less at the other stations.

Across all Scoop to BART stations, system activity was estimated to have increased the number of persons per parked vehicle by 0.81% at the end of the evaluation period. Although these findings constitute an upper bound of impacts, they suggest that Scoop likely increased the number of persons per vehicle at BART stations, yielding a partially-supported hypothesis.

Hypothesis 7: The technological changes to carpooling have caused people who would have driven alone to carpool to BART stations

The evaluation found that a considerable share of Scoop users would have driven alone or traveled in an SOV (including Transportation Network Companies [TNCs] such as Uber or Lyft) had Scoop not been available. Through a survey of Scoop users, it was found that 41% of respondents would have driven alone to or from BART, 14% would have taken Uber or Lyft, and 9% would have had someone drop them off or pick them up at the BART station. All of these alternatives would have increased vehicles miles of travel (VMT) relative to carpooling. Others reported shifts from public transit (11%), walking or bicycling (4% together), and not taking the trip at all (8%).

Hypothesis 8: The expansion of Scoop to all BART stations will lower VMT and reduce greenhouse gas (GHG) emissions that would have occurred in its absence

These responses were combined with the Scoop activity data to evaluate the change in VMT that likely resulted from Scoop. The evaluation found that Scoop very likely caused some substantive declines in VMT during the evaluation. The analysis suggested, with survey-derived mode shifts applied to the activity data, that 44% of Scoop trips reduced VMT, 12% of Scoop trips increased VMT, and 44% imposed no change in VMT. Overall, the balance of these impacts suggested that Scoop facilitated a decline in VMT.

Hypothesis 9: Overall ridership increases as a result of the Scoop program

Evaluation of survey data found that Scoop users reported increased frequency of the use of BART and that they used BART more because of Scoop. An analysis of ridership data was not able to empirically isolate coefficients attributing changes in ridership to Scoop; BART ridership is simply too large relative to the size of Scoop activity to identify impacts using econometrics or statistical tests. Impacts of Scoop on revenue were subject to similar findings.

Hypothesis 10: Users of the Scoop application reduce their cost of travel relative to their previous method of travel to BART or commuting

A large minority (40%) of Scoop users reported reduced cost relative to their primary alternative as a reason for traveling with Scoop. Additionally, 30% of users who were also drivers considered cost recovery as a key reason for using Scoop. Other cited reasons for using Scoop included the ability to access station parking (58%), flexibility in arrival times (46%), offering an alternative to driving (43%), traveling faster (40%), and improved safety of travel (18%).

Hypothesis 11: Enforcement and abuse of Scoop permits are low, with a fraud rate less than 5%

BART enforcement staff noted that the rates of fraudulent use with Scoop are very likely to be lower than those with the legacy carpool program. Fraudulent use of the legacy carpool program spaces is identified only as the person leaves the car without another passenger, whereas permit violations with Scoop, in part, could be determined through a review of a list of license plates assigned to carpools going to BART.

Hypothesis 12: The marginal cost for BART for implementing the program is less than the revenue earned from additional ridership

The findings of the evaluation found that Scoop appeared to have a positive impact on ridership, which would lead to the conclusion that additional revenue was obtained from this increase in ridership. However, the Scoop activity was not large enough to be statistically visible within the broader fluctuations of the monthly ridership activity that occurs with BART. Because Scoop activity data noted only the BART system access station, not the BART system destination, fare generated by this activity was not computable. It was determined to be inconclusive as to whether the ridership revenue gained by the additional ridership enabled by Scoop exceeded the marginal costs of implementing the project.

Hypothesis 13: The process of deploying the project will produce lessons learned and recommendations for future research and deployment

The Scoop project offered lessons learned to build on future projects. Expert interviews revealed several findings related to contractual negotiations, project operation and expansion, accessibility challenges, and other issues related to the continuation of the project. Project stakeholders/partners were generally satisfied with the project, even though it did not grow as expected at many stations, particularly those not at the terminus of a line or near a highway bottleneck.

The full report presents detailed findings of the evaluation of the BART project with Scoop, with lessons learned that potentially can help advance similar initiatives within other transit systems.

Table ES-1

Summary of Findings

Hypothesis	Status	Key Finding
Hypothesis 1: Carpooling to stations increases following the implementation of the Scoop to BART pilot project.	Supported	Analysis of Scoop data and survey data strongly suggests that carpooling to and from BART increased as a result Scoop.
Hypothesis 2: Utilization of parking spaces by carpooling vehicles increases.	Supported	The utilization of parking by carpooling vehicles increased as a result of Scoop.
Hypothesis 3: The cost per enforcement per carpool space declined with no sacrifice in enforcement quality.	Supported	Cost for enforcement per carpool space declined given the large number of spaces added as a result of the program.
Hypothesis 4: The number of instances of illegal carpool spaces per total carpool spaces available will be lower than before the pilot initiation.	Inconclusive	Data available did not enable a direct evaluation of the number of carpool violations; thus, a quantified assessment of this hypothesis was indeterminable.
Hypothesis 5: The distribution of legal arrivals to carpool spaces will be closer to a uniform distribution between the hours of 6 am and 10 am than before the pilot.	Supported	The Scoop to BART pilot program enabled greater travel time flexibility among carpool travelers.
Hypothesis 6: The number of persons per vehicle at BART stations increases after the program.	Partially Supported	This hypothesis could not be directly evaluated using empirical data. Based on the applied assumption, the increased occupancy of Scoop vehicles likely increased the persons per vehicle at BART stations by percentages that are above zero, but less than the calculated upper bounds.
Hypothesis 7: The technological changes to carpooling have caused people who would have driven alone to carpool to BART stations.	Supported	A large share of respondents reported a shift from driving alone to Scoop, strongly suggesting that Scoop enabled a significant share of users who would have opted to drive alone to BART to carpool instead.
Hypothesis 8: The expansion of Scoop to all BART stations will lower VMT and reduce GHG emissions that would have occurred in its absence.	Supported	Given the notable shift of users away from SOV trips, the results of this numerical experiment and the findings of the survey suggest that the Scoop to BART program was reducing net VMT.
Hypothesis 9: Overall ridership increases as a result of the Scoop program.	Supported	Although the analysis of ridership data could not identify an impact of Scoop within broader BART ridership levels, survey responses strongly suggested that a sizeable minority of individuals using Scoop had increased their BART use as a result of the program, thus increasing BART ridership.
Hypothesis 10: Users of the Scoop application reduce their cost of travel relative to their previous method of travel to BART or commuting.	Supported	Although available data did not permit an activity-based analysis of cost impacts to users, survey results indicated that a sizable minority felt that Scoop was lowering their cost or net cost of travel to BART.
Hypothesis 11: Enforcement and abuse of Scoop permits are low, with a fraud rate less than 5%.	Partially Supported	Fraudulent use could not be directly measured during the evaluation and had to be qualitatively assessed. BART enforcement staff felt that fraudulent use had been lowered considerably due Scoop, but believed it was still higher than 5%.
Hypothesis 12: The marginal cost for BART for implementing the program is less than the revenue earned from additional ridership.	Inconclusive	It is inconclusive as to whether the ridership revenue gained by the additional ridership enabled by Scoop exceeded the marginal costs of implementing the project.
Hypothesis 13: The process of deploying the project will produce lessons learned and recommendations for future research and deployment.	Supported	Project stakeholders/partners were generally satisfied with the project.

SECTION

1

Introduction

Overview of MOD Sandbox Demonstrations

The Federal Transit Administration (FTA)'s Mobility on Demand (MOD) effort developed around a vision of a multimodal, integrated, automated, accessible, and connected transportation system in which personalized mobility is a key feature. FTA selected 11 MOD Sandbox Demonstration projects that are testing solutions that advance the MOD vision. In partnership with public transportation agencies, the MOD Sandbox is demonstrating the potential for new innovations to support and enhance public transportation services by allowing agencies to explore partnerships, develop new business models, integrate transit and MOD solutions, and investigate new, enabling technical capabilities.

Evaluation of each project's benefits and impacts will guide the future implementation of innovations throughout the U.S. Broadly, MOD Sandbox projects take several approaches, including the development of new or improved trip planners, integration of new mobility services with traditional public transit functions, and implementation of new integrated payment and incentive structures for travel using public transit. Several Sandbox projects focus on improving first/last-mile access to public transportation through collaboration with private sector operators, including bikesharing, carsharing, ridesourcing/ Transportation Network Companies (TNCs), and other shared mobility operators.

Table 1-1 provides a summary of all projects in the MOD Sandbox Program.

Table 1-1

Overview of MOD Sandbox Projects

Region	Project	Description
Chicago	Incorporation of Bikesharing Company Divvy	Releases updated version of Chicago Transit Authority's (CTA) existing trip planning app. New version incorporates Divvy, a bikesharing service, and allows users to reserve and pay for bikes within the app.
Dallas	Integration of Shared-Ride Services into GoPass Ticketing Application	Releases updated version of Dallas Area Rapid Transit's (DART) existing trip planning app. Updated version incorporates shared-ride services to provide first/last-mile connections to public transit stations and allows users to pay for services within the app.
Los Angeles and Puget Sound	Two-Region Mobility on Demand	Establishes partnership between Via and LA Metro. Via provides first/last-mile connections for passengers going to or leaving from transit stations. There is a companion project in Seattle, WA.
Phoenix	Smart Phone Mobility Platform	Releases updated version of Valley Metro's existing trip planning app. New version updates trip planning features and enables payments.
Pinellas County (Florida)	Paratransit Mobility on Demand	Improves paratransit service by combining services from taxi, ridesourcing/TNCs, and traditional paratransit companies.
Portland	Open Trip Planner Share Use Mobility	Releases updated version of TriMet's existing multimodal app. New version provides more sophisticated functionality and features, including options for shared mobility.
San Francisco Bay Area	Bay Area Fair Value Commuting (Palo Alto)	Reduces SOV use within Bay Area through commuter trip reduction software, a multimodal app, workplace parking rebates, and first/last-mile connections in areas with poor access to public transit.
	Integrated Carpool to Transit (BART System)	Establishes partnership between Scoop and BART. Scoop matches carpoolers and facilitates carpooling trips for passengers going to or leaving from BART stations with guaranteed parking.
Tacoma	Limited Access Connections	Establishes partnerships between local ridesourcing companies/TNCs and Pierce Transit. Ridesourcing companies provide first/last-mile connections to public transit stations and park-and-ride lots with guaranteed rides home.
Tucson	Adaptive Mobility with Reliability and Efficiency	Built integrated data platform that incorporates ridesourcing/TNC and carpooling services to support first/last-mile connections and reduce congestion.
Vermont	Statewide Transit Trip Planner	Releases new multimodal app for VTrans that employs fixed and flexible (non-fixed) transportation modes to route trips in cities and rural areas.

An independent evaluation (IE) is required by Federal Public Transportation Law (49 U.S.C. § 5312(e)(4)) for demonstration projects receiving FTA Public Transportation Innovation funding. The IE for the MOD Sandbox Demonstration projects was sponsored by the USDOT Intelligent Transportation Systems Joint Program Office (ITS JPO) and FTA.

This report focuses on the evaluation of the project with the Bay Area Rapid Transit (BART) system implemented in the San Francisco Bay area. The project, entitled BART Integrated Carpool to Transit, consisted of collaboration between BART and Scoop to deliver an upgraded carpooling matching platform for people traveling on BART. The evaluation of this project involved exploring a number of hypotheses surrounding the project's impact on ridership, vehicle miles traveled (VMT), parking, and agency revenue and cost. Following a more detailed overview of the project, these hypotheses are explored in the sections that follow.

Evaluation Framework

For each of the 11 MOD Sandbox projects, the IE team developed an evaluation framework in coordination with the project team. The framework is a project-specific logic model that contains the following entries:

1. **MOD Sandbox Project** – denotes the specific MOD Sandbox project.
2. **Project Goals** – denotes each project goal for the specific MOD Sandbox project and captures what each MOD Sandbox project is trying to achieve.
3. **Evaluation Hypothesis** – denotes each evaluation hypothesis for the specific MOD Sandbox project. The evaluation hypotheses flow from the project-specific goals.
4. **Performance Metric** – denotes the performance metrics used to measure impact in line with the evaluation hypotheses for the specific MOD Sandbox project.
5. **Data Types and Sources** – denotes each data source used for the identified performance metrics.
6. **Method of Evaluation** – denotes the quantitative and qualitative evaluation methods used.

SECTION

2

BART MOD Sandbox Project Summary

BART is the fifth-busiest heavy rail rapid transit system in the U.S., carrying more than 430,000 daily riders. BART provides service in northern California in four Bay Area counties—Alameda, Contra Costa, San Francisco, and San Mateo. The BART system comprises 107 miles of track, 46 stations, and 669 revenue vehicles and provides access to many of the San Francisco Bay Area's key destinations for work, school, and recreation. BART has more than 3,400 employees and a combined annual capital and operating budget of more than $1.5 billion. Figure 2-1 presents a map of the BART system in 2019.

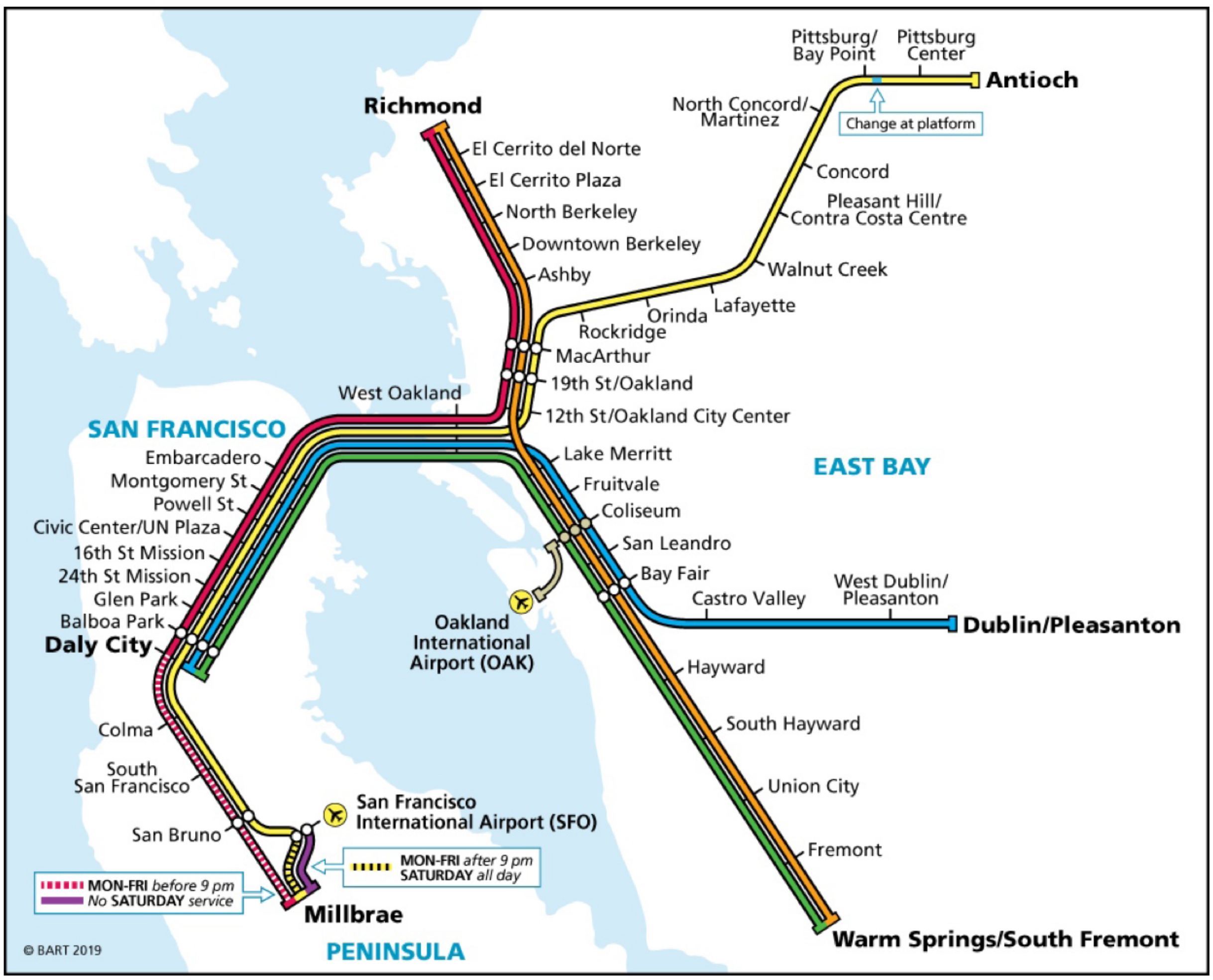


Figure 2-1

BART system map 2019

BART, the Metropolitan Transportation Commission (MTC), and Scoop Technologies, Inc. (Scoop), partnered on a program to better integrate carpool access to public transit by matching passengers with a transit station as their destination and providing a seamless way to reserve and pay for highly-coveted parking spaces at BART stations.

BART offers 48,000 parking spaces at 34 of its 46 stations, with a parking mix that includes "daily fee" first-come/first-served spaces (approximately 35,000), permit spaces (approximately 12,000), and a small number of carpool spaces (approximately 900). Demand for parking is often high, with the majority of spaces filling by 8:00 AM each weekday. However, according to a 2015 passenger profile survey, only about 0.8% of riders parking at BART carpooled with others to get to the station. As most vehicles remain parked all day, the majority of parking spaces serve just one patron per day.

BART has a legacy carpool permitting program that provides dedicated carpool spaces at 21 BART stations. The program operates with first-come/first-served carpool spaces, but enforcement is challenging and the spaces are difficult to preserve for legitimate carpools. Hence, preventing fraudulent use of these spaces by single-occupancy vehicles (SOVs) requires live observation of passengers as they exit their vehicles, which ultimately is very staff intensive and impractical given the resources and spatial spread of the BART system. As a result, BART does not provide dedicated carpool spaces at one third of its stations and has been reluctant to expand the number of spaces at stations at which the legacy carpool program exists.

The MOD partnership between BART, MTC, and Scoop aimed to address some of the issues that were previously limiting BART from expanding carpooling options. The Scoop platform matches drivers and passengers with similar destinations into carpools through a smart phone app. MTC and Scoop had been working together since 2015 to promote carpooling in the Bay Area region, and in 2016, BART, MTC, and Scoop extended this collaboration to develop a pilot program that would use the Scoop app to match users going to BART stations into carpools and, as an incentive, would guarantee a parking space at the BART station.

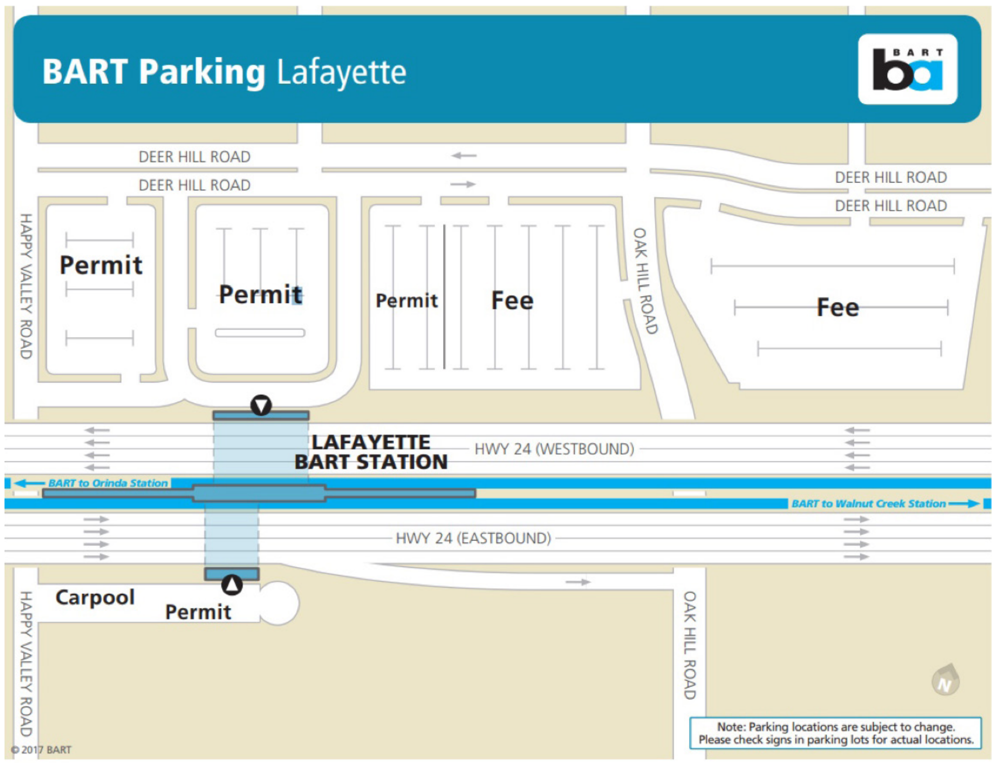
Scoop operates by matching drivers and riders the night before a weekday commute. In the morning, drivers would leave their home, find the matched rider using information provided by the Scoop app, then proceed to the rider's destination. Drivers were matched by Scoop to pick up, at most, two riders along their trip. The destination of the rider could differ from that of the driver, but for the trip to be considered a Scoop to BART "project trip," the destination of at least one of the occupants had to be a BART station. There were also trips that started at the BART station in the evening and took Scoop riders and drivers home. Drivers were compensated half the standard $0.545 per mile per rider.

Hence, the driver received the full rate if there were two riders and half the rate if there was only one. Riders gained access to carpool lanes and did not have to drive.

Parking at BART stations is generally divided into three types—permit parking locations, fee parking locations, and legacy carpool parking locations. Drivers and riders matched by the project were allowed to park anywhere in BART's permit parking areas. The legacy carpool spaces were also retained for the legacy carpool program at stations where they existed. Figure 2-2 shows a schematic of the Lafayette BART station as an example of how parking is laid out.

Figure 2-2

Schematic of parking at Lafayette BART station



Source: BART

The number of legacy carpooling parking spaces is typically constrained relative to parking allocated for other purposes. Because the number of users matched and the number of vehicles parking at BART could vary from day to day, BART had to provide flexibility in the number of vehicles that could park to accommodate Scoop traffic. BART permit parking spaces were reserved for permit holders and matched Scoop drivers until 10:00 AM, offering passengers more flexibility about when to arrive at the station. Scoop provided the license plates of matched drivers to BART on a daily basis, and BART used this information to enforce the program.

The pilot program was initially launched at the Dublin/Pleasanton BART station in January 2017 before the official beginning of the grant. During the MOD Sandbox grant period, the project expanded to 16 additional stations across the system. Total project funding was $521,000, including $358,000 in USDOT funds from the MOD Sandbox grant and $163,000 in matching funds from the three project partners. The project deployed the Scoop program to 17 stations along with their respective parking capacities, as categorized by permit parking, legacy carpool parking, and fee parking.

Table 2-1 lists the Scoop BART stations in order of their Scoop deployment and shows that the allocation to legacy parking spaces was generally limited to 0–5% of the total space allocation, with an average of 2% across all Scoop BART stations. Permit parking, which includes parking allocated to monthly permits, daily reservation permits, and airport/long-term parking permits, comprised 7–45% of station parking, with an average of 20% of spaces across all Scoop BART stations.

Another indicator in Table 2-1 is a Boolean variable reporting whether the legacy carpool spaces would fill up by 10:00 AM. There is no parking sensing at BART stations, so any activity data would be derived from payments. As much of permit parking is not paid for on daily basis, including legacy carpool permit parking, BART has only a general understanding of the utilization of legacy carpool spaces. However, that understanding shows that legacy carpool spaces, at their limited capacities, were (and still are) severely impacted. The objective of the Scoop project was to open up the larger capacities of permit parking to carpooling activity in ways that could be monitored and enforced.

Project Timeline

The main milestones for the BART program are as follows:

- **January 23, 2017** – Launch of pilot Scoop demonstration at Dublin/Pleasanton BART station (pre-grant pilot).
- **February 14, 2017** – Agreement execution date for MOD Sandbox grant with USDOT.
- **September 2017** – Demo start—Launch of MOD field demonstration at Millbrae and San Bruno BART stations. Program continued to roll out about 2 stations per month through June 2018.
- **April 2019** – Field demonstration of launch program complete.

BART collected data relevant to this MOD demonstration between January 2017 and April 2019, and the evaluation period was between July 2017 and April 2019.

Table 2-1

Parking Spaces at Scoop BART Stations

Stations	Permit Parking Spaces	Legacy Carpool Parking Spaces	Fee Parking Spaces	Total Parking Spaces	Legacy Carpool Parking Fills by 10:00 am?	Percentage of Permit Spaces	Percentage of Carpool Legacy Spaces	Scoop to BART Launch Date
Dublin/Pleasanton	645	129	2,112	2,886	Yes	22%	4%	1/23/2017
Millbrae	597	21	2,360	2,978	Yes	20%	1%	9/12/2017
San Bruno	205	16	837	1,058	No	19%	2%	9/12/2017
Concord	175	52	2,131	2,358	Yes	7%	2%	10/23/2017
Pleasant Hill	630	65	2,242	2,937	Yes	21%	2%	10/23/2017
Orinda	463	0	898	1,361	Yes	34%	0%	11/13/2017
Rockridge	400	13	479	892	No	45%	1%	11/13/2017
Union City	260	14	870	1,144	Yes	23%	1%	2/12/2018
Colma	265	72	1,433	1,770	Yes	15%	4%	3/26/2018
Daly City	525	59	1,475	2,059	Yes	25%	3%	3/26/2018
South San Francisco	135	9	1,235	1,379	No	10%	1%	3/26/2018
Warm Springs	430	62	1,590	2,082	No	21%	3%	5/1/2018
Lafayette	424	22	1,082	1,528	Yes	28%	1%	5/7/2018
Walnut Creek	385	32	878	1,295	Yes	30%	2%	5/14/2018
North Concord	172	41	1,767	1,980	Yes	9%	2%	5/21/2018
Antioch	163	15	862	1,040	Yes	16%	1%	5/29/2018
West Dublin/Pleasanton	215	65	910	1,190	Yes	18%	5%	6/4/2018
Total	*6,089*	*687*	*23,161*	*2,9937*	*NA*	*20%*	*2%*	*NA*

SECTION

3

Evaluation Approach, Planning, and Execution

The evaluation of the MOD Sandbox project was guided by an evaluation plan developed at the outset of the project. The evaluation plan was built primarily off of a logic model constructed by the IE team and had five basic components:

1. **Project Goal** – The stated goal of the project; project goals were defined from the proposal, project summary, and discussion with project team members.
2. **Evaluation Hypothesis** – Each project goal had a corresponding hypothesis, a statement that could be answered with "Yes" or a "No" that was related to measuring the achievement of the associated project goal.
3. **Performance Metric** – Described the measurement that was proposed to be used to evaluate the hypothesis.
4. **Data Sources** – Data sources that followed the performance metric and described the data type and source necessary to compute or evaluate the performance metric.
5. **Method of Evaluation** – Defined how the hypothesis would be evaluated; with the logic model, this was very general, declaring whether the evaluation would be completed via survey analysis, activity data analysis, time series analysis, or other methods.

The logic model was effectively a table, with one row containing five cells, each populated with the components described above. The content of the logic model was also populated in advance of project implementation, where knowledge of the project trajectory and exact data collected were uncertain. The first four components of the logic model constructed for the evaluation of the BART project are presented in Table 3-1.

The quantitative and qualitative evaluation methods used in the BART IE include the following:

- Time series and cross-sectional analysis
- Statistical analysis, expert interviews
- Survey analysis
- Survey and activity data analysis
- Survey and revenue analysis
- Summary of expert interviews

The content of the logic model was translated into a data collection plan, which was incorporated into a broader evaluation plan. The evaluation plan contains further details on the proposed data structures and analytical approaches to address each hypothesis. The evaluation plan was reviewed by project stakeholders and finalized at the inception of the project. The project team then executed the project, working with the evaluation team to collect and transfer data at key junctures of the project. The next section presents background on the data collected in support of the evaluation and a presentation and discussion of the results from the evaluation.

Table 3-1

Evaluation Hypotheses, Performance Metrics, and Data Sources for BART Sandbox Project

Evaluation Hypothesis	Performance Metric	Data Elements	Data Sources
1. Carpooling to stations increases following the implementation of the Scoop to BART pilot project.	Total number of carpooling riders to each BART station	Count of people carpooling to BART stations by station by hour	Scoop data/license plate logs
2. Utilization of parking spaces by carpooling vehicles increases.	Number of verified carpool vehicles	Spaces occupied by carpooling vehicles before and after pilot by station by day	BART parking data/ scoop license plate logs
3. The cost of enforcement per carpool space declines with no sacrifice in enforcement quality.	Cost and time spent on carpool enforcement per carpool space	Hours of labor devoted to carpool enforcement; count of cumulative carpool spaces available by station by day	BART parking enforcement
4. The number of instances of illegal use of carpool spaces per total carpool spaces available will be lower than before the pilot initiation.	Total number of citations given to illegal carpool vehicles over time	Citations per station per day	BART parking enforcement
5. The distribution of legal arrivals to carpool spaces will be closer to a uniform distribution between the hours of 6 am and 10 am than before the pilot.	Carpool arrival by station by hour	Arrivals of carpool vehicles by station by hour	Scoop data logs
6. The number of persons per vehicle parking at BART stations increases after the program.	Number of persons per vehicle parking at BART	Number of SOVs parking, number of carpool vehicles parking, carpool vehicle occupancy, total number of spaces utilized	BART parking data
7. The technological changes to carpooling have caused people who would have driven alone to carpool to BART stations.	Estimated total number of people who would be driving alone to work without project	[Self-reported] Number of people who would be driving alone to work without project	User survey
8. The expansion of Scoop to all BART stations will lower VMT and reduce GHG emissions that would have occurred in its absence.	Measured travel behavior change and estimated emissions change	Scoop user origin and destinations,	User survey, Scoop data
9. Overall ridership increases as a result of the Scoop program.	Ridership at all stations over time	Ridership data time-series of stations	BART farebox data

Table 3-1 (cont.)

Evaluation Hypotheses, Performance Metrics, and Data Sources for BART Sandbox Project

Evaluation Hypothesis	Performance Metric	Data Elements	Data Sources
10. Users of the Scoop application reduce their cost of travel relative to their previous method of travel to BART or commuting.	Cost of travel by users prior to Scoop	[Self-reported] Fare paid by users to commute, BART fare tables	User survey, BART data
11. Enforcement and abuse of Scoop permits are low, with a fraud rate less than 5%.	Measured fraud rate of Scoop permits	Number of illegally-used Scoop permits per station per day	BART parking enforcement/Scoop license plate logs
12. The marginal cost to BART for implementing the program is less than the revenue earned from additional ridership.	Estimated revenue gain from ridership increases, and parking exceeds the marginal cost incurred by BART to implement the Scoop program	Ridership, revenue, marginal costs incurred by BART (operational)	BART, MTC, Scoop data
13. The process of deploying the project will produce lessons learned and recommendations for future research and deployment.	Lessons learned and recommendations	Qualitative documentation from stakeholder interviews	Stakeholder interviews

Data Collected

A variety of datasets was used to conduct the evaluation. These datasets were collected in collaboration with BART and were in the form of surveys, ridership data, trip activity data from Scoop, citation data, and expert interview data, as follows:

- **Survey Data** – A survey of Scoop users was launched at three separate times during the evaluation. The first was in August 2017, the second was in February/March 2018, and the final launch was in June 2019. The survey was designed to ask questions about the use of Scoop and the resulting impacts on travel behavior.
- **Ridership Data** – To evaluate whether Scoop had any large-scale impacts on ridership and revenue, the evaluation team was provided with origin/destination ridership data from BART that spanned from 2015 to June 2019.
- **Activity Data** – Activity data of Scoop users was provided that described the trips of individual carpoolers. These data were used to derive other attributes of the trip to execute the analysis of several hypotheses. The dataset had the following attributes:
    - Trip start time
    - Driver/rider Boolean
    - Size of total carpool
    - Number of carpoolers going to BART

- Shared distance of trip
- Whether trip was part of AM or PM direction
- BART station to which trip connected

- **Citation Data** – Annual permit citation data were provided for selected stations within the Scoop pilot.
- **Expert Interview Data** – Expert interviews were conducted with several members of the BART project team who had deep knowledge of the project. These interviews were conducted in August 2019 and covered lessons learned, challenges and barriers, and key institutional findings.

These datasets were applied to evaluate the hypotheses defined within the evaluation plan.

SECTION 4

Evaluation Results

This section explores the defined hypotheses and addresses the questions they posit using the data available.

Hypothesis 1: Carpooling to stations increases following the implementation of the Scoop to BART pilot project.

Performance Metric	Key Finding
Total number of carpooling riders to each BART station	Analysis of Scoop data and survey data strongly suggests that carpooling to and from BART increased as a result of Scoop.

The first hypothesis explored as part of the evaluation was whether the project increased carpooling to stations. This hypothesis was evaluated using both activity data of Scoop and survey data of Scoop users. Activity data provided by Scoop permitted the evaluation of trends in carpooling to BART station. Surveys asked respondents questions about their carpooling activity. Together, these data were used to evaluate whether carpooling to stations increased as a result of the project.

Although the MOD demonstration officially started in September 2017, the data presented spans three months prior. By the start of the evaluation period, BART had launched a pre-grant pilot of Scoop at the Dublin/Pleasanton BART station in January 2017. At the start of the evaluation period, five additional stations had Scoop activity—Warm Springs, West Dublin/Pleasanton, Millbrae, San Bruno, and Union City. However, activity at these stations was prior to the launch of the BART program at Scoop and was occurring independently. The sections that follow provide analysis of activity that occurred at BART stations after the formal launch of the MOD Sandbox project as well as analysis of the impact the launch had on the activity at the selected stations that had substantive natural activity prior to the formal launch of the BART program.

Figure 4-1 shows the trend in total carpooling to BART stations that took place during the evaluation period. This ramp-up period permitted the BART system to have a base carpooler activity rate from Scoop of about 2,600 per month per station during the third quarter of 2017. The labeled vertical lines show when stations were added during the project. The majority of this activity was produced by the Dublin/Pleasanton station throughout the evaluation period. Dublin/Pleasanton was the first station to be open to Scoop and has the third largest parking lot in the system (the largest being Millbrae, followed by Pleasant Hill). The dominance of this station was present throughout the entire project and was likely due to its size and location within the BART system. It is situated at a terminus of the system and operates in a highly auto-oriented environment with limited transit. This contrasts to Pleasant Hill, which is in the middle of the Antioch line. Millbrae is also at a terminus but is within a corridor better served by rail transit, including Caltrain, which runs the corridor between San Francisco and San Jose.

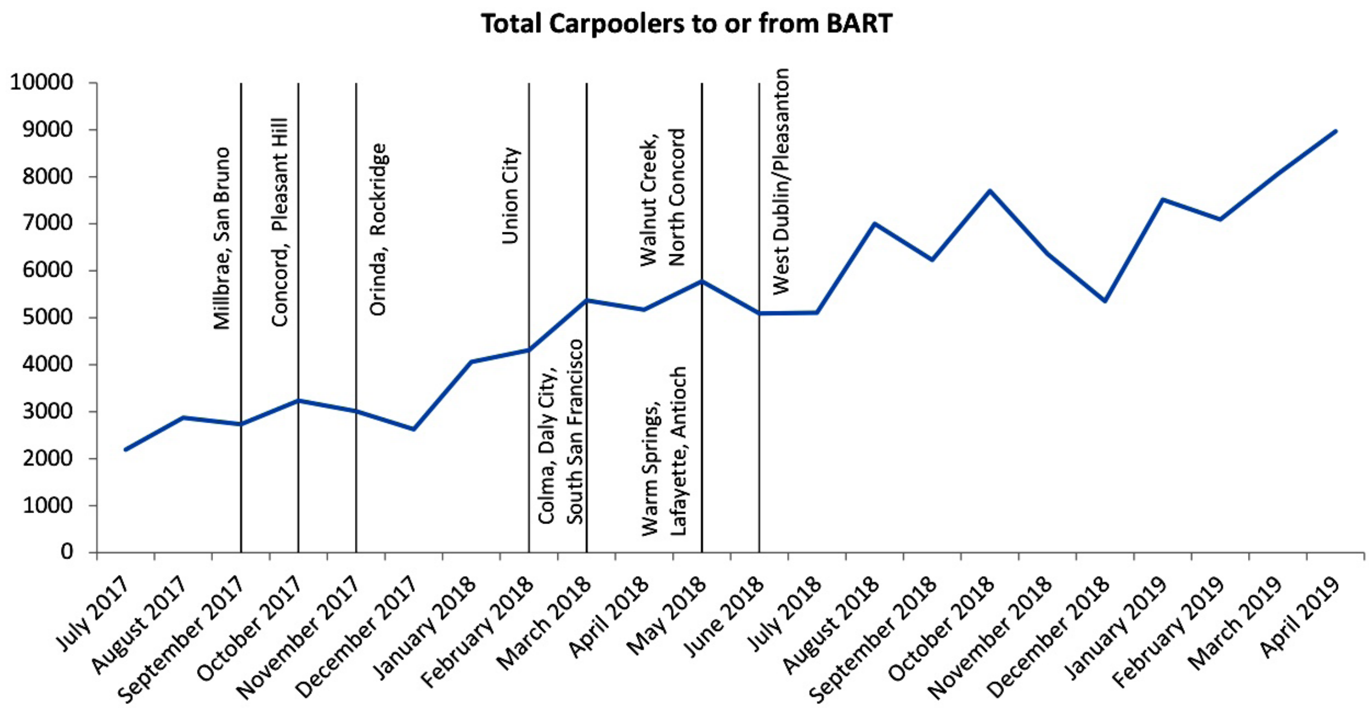


Figure 4-1

Total carpool person-trips to or from BART system via Scoop

Figure 4-2 shows the trends in carpooling activity after program launch, broken out by station, indicating that much of the upward trend during the evaluation period was driven by the Dublin/Pleasanton station. During the entire evaluation period, this station registered a total of 81,634 carpoolers traveling to the station (carpool person-trips). The station with the second largest activity was southern terminus Warm Springs (9,953 carpooler trips), followed by Orinda (8,376 carpooler trips), which is just east of the Caldecott Tunnel, a major Bay Area bottleneck, then eastern terminus Antioch (5,507 carpooler trips). Collectively, all other stations excluding Dublin/Pleasanton, comprised 30% of the carpooling activity. During the period between July 2017 and April 2019, there were 115,806 Scoop carpooler trips to or from a BART station.

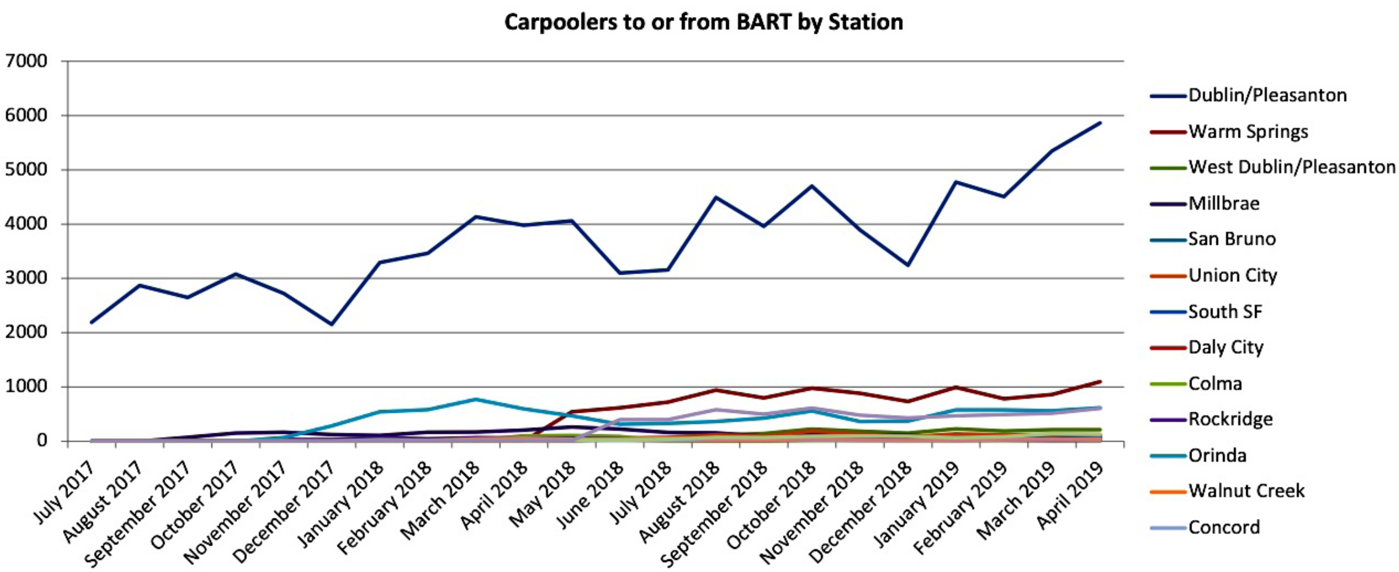


Figure 4-2

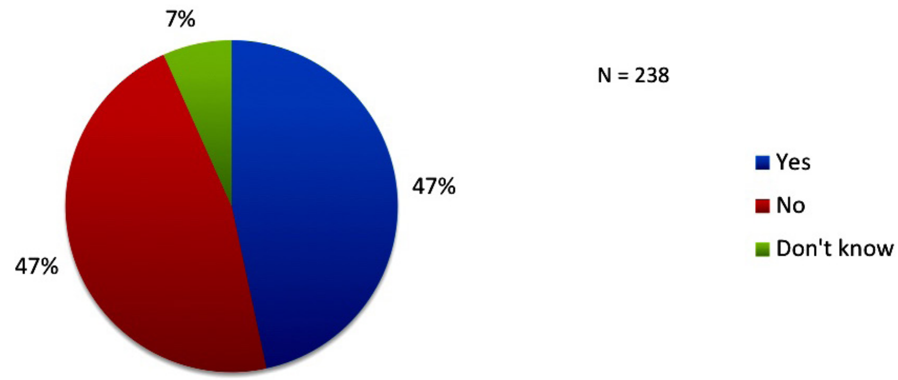
Carpoolers to or from BART by station after program launch

The trends of increasing carpooling activity suggest that carpooling increased as a result of the Scoop to BART Pilot. As noted, legacy carpool spaces would fill up at 13 of the 17 stations at which Scoop was deployed. Carpool permit parking continued to fill to capacity during the Scoop pilot, strongly suggesting that most carpooling through Scoop was additional carpooling beyond what was already happening in the carpool permit areas. This was because the legacy program was maintained with no changes. Those using regular carpool permits had limited incentive to switch to using Scoop, as they already had a permit to park at BART and presumably had a carpool partner. Legacy carpool users needed to pay for parking at BART but did not need to pay each other for their carpool trip, as Scoop users did. The means that with no change in carpooling, carpool permit users switched to using Scoop; it would be unlikely that a large number of BART carpool permit holders would suddenly switch to using Scoop, leaving the carpool permit lots empty. This shift was not reported to have occurred at the legacy permit lots, strongly suggesting that most of, if not all, Scoop activity was additional carpooling to BART. The legacy lots remained at their pre-pilot utilization (generally at capacity) throughout the pilot, so the new activity from Scoop was additional carpoolers.

A key motivation for BART to coordinate with Scoop on the program was that many legacy carpool permit spaces were known to be used fraudulently, with high numbers of SOVs using legacy spaces. Data collected in the survey strongly suggested that many Scoop users were new carpooling users, beyond those already using carpool permit lots. Some may have considered carpooling to stations, as the Scoop to BART program offered more flexibility than the legacy carpool program by matching irregular BART riders into carpools. The survey asked respondents if they were on the wait list for BART monthly parking permits. Figure 4-3 reveals that almost half of all respondents were on the wait list. This large percentage suggests that they are regular BART riders and may have used the Scoop to BART program to obtain access to a parking space. Overall, analysis of Scoop data and survey data strongly suggests that carpooling to and from BART increased as a result Scoop.

Figure 4-3

Are you currently on the wait list for a BART parking permit?



The launch of the Scoop program had an impact on Scoop carpooling activity at a number of stations. The BART station with the largest activity was Dublin/Pleasanton, which was part of the Scoop to BART program during the entire evaluation period. All other stations were launched during the evaluation period. Among those with the four largest carpooler levels of activity were Warm Springs, Orinda, Millbrae, and West Dublin/Pleasanton. Antioch had activity levels higher than Millbrae, but it opened with Scoop active, providing no opportunity for pre-launch activity. These four stations may have taken Scoop carpoolers prior to the program, and three of the four had "non-program" related activity prior to BART's formal launch at the station. Figure 4-4 shows the level of carpooling using Scoop before and after the launch of the program for these four stations. The vertical line shows the launch point for each station.

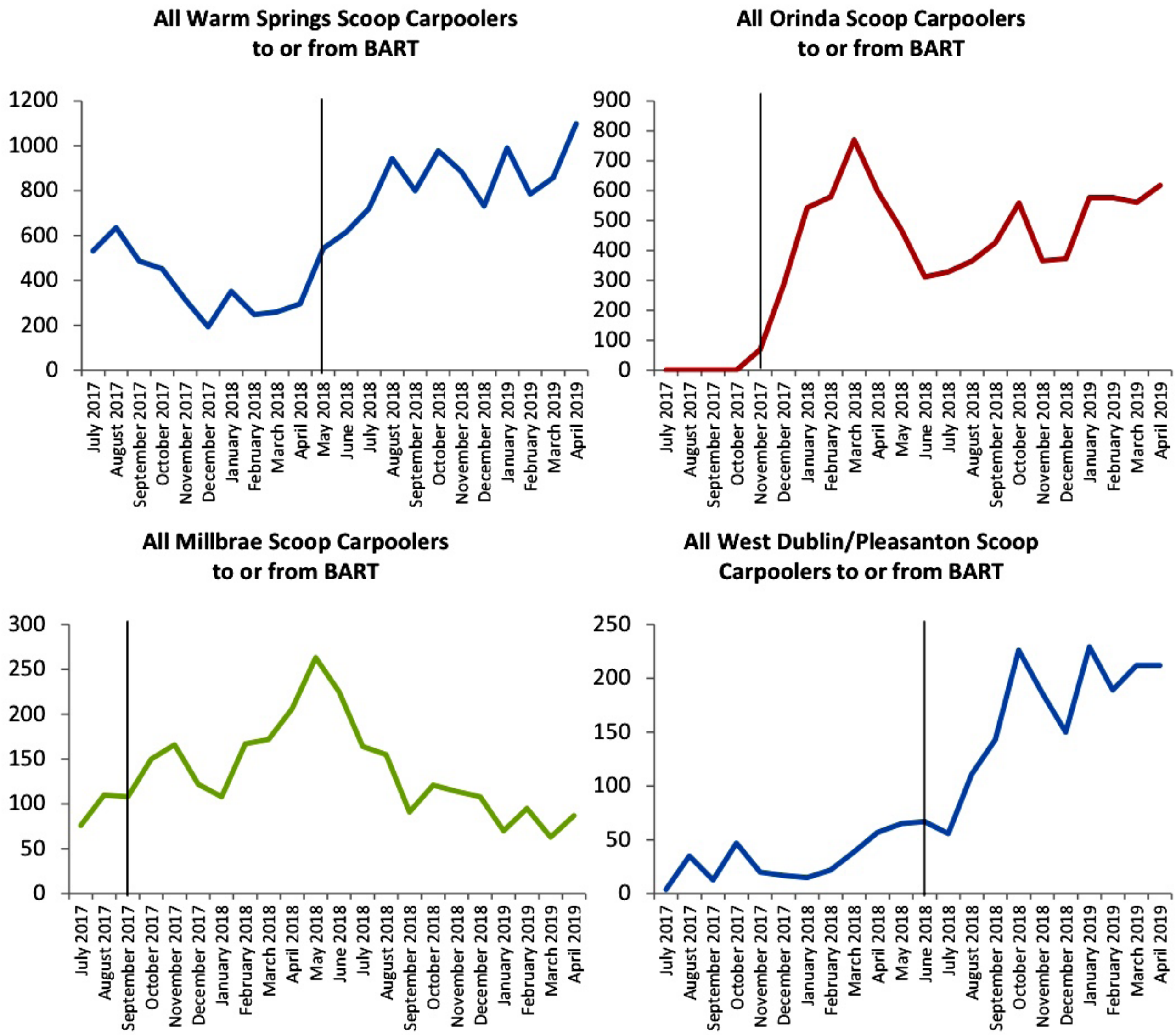


Figure 4-4

Scoop activity before and after launch at four stations

Activity before and after launch show an upward trend after launch at each station. For three of the stations, Warm Springs, Orinda, and West Dublin/Pleasanton, there is a notable uptick in activity that remained elevated throughout the evaluation period. Millbrae also registered a rise in activity that continued for about nine months before falling to pre-launch levels. Reasons for this fall could be varied and, at the levels shown at this station, could be caused by a few users switching regular use from one station to another or ceasing their use of Scoop altogether. Overall, the level of Scoop activity observed prior to launch at individual stations was low relative to the level after launch.

During the entire evaluation period, across all Scoop stations, there were 120,571 Scoop carpool trips. With 115,806 of those occurring after launch, only 4,765 trips were registered at the stations before a Scoop launch.

In the sections that follow, we focus exclusively on the trips that occurred at the station after launch of the BART program.

Hypothesis 2: Utilization of parking spaces by carpooling vehicles increases.

Performance Metric	Key Finding
Number of verified carpool vehicles	Utilization of parking by carpooling vehicles increased as a result of Scoop.

Evaluating the utilization of parking spaces by Scoop carpooling vehicles follows the analysis of Scoop carpoolers. Scoop activity data reported carpool sizes (2 or 3 persons) and the number of BART carpoolers within the carpool. Two-person carpools were dominant, comprising 88% of all carpools. Often, the driver and passenger(s) were going to BART. However, Scoop carpool vehicles could drop off passengers and continue on elsewhere, adding a rider at BART but not using a station parking space. Alternatively, Scoop carpool vehicles could drop off a passenger somewhere other than BART and then park at the BART station. This latter scenario was less common but the vehicle would appear to be an SOV upon arrival. The data permitted a distinction of these scenarios in the context of the parking activity that occurred at the BART station. Figure 4-5 shows the trend in vehicles that parked at each station and across the BART system as a result of Scoop activity. As with carpoolers, the activity at the Dublin/Pleasanton BART station constituted the majority of all Scoop-related parking events. In total, 47,998 vehicles parked at participating stations between July 2017 and April 2019. With 34,122 parking events, the Dublin/Pleasanton station comprised about 71% of that activity.

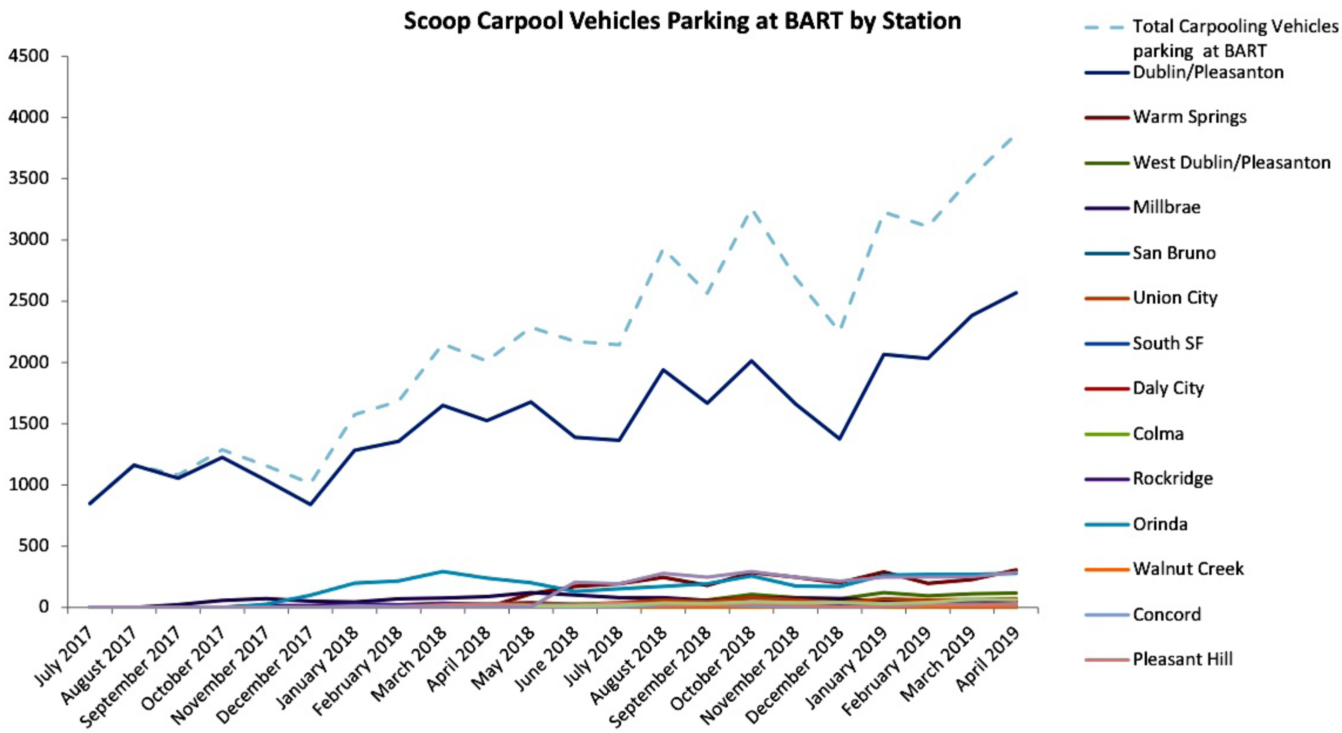


Figure 4-5

Scoop carpools parking at BART stations

The calculation of Scoop parking events and Scoop carpoolers allowed the calculation of Scoop carpoolers per Scoop vehicle parked. This metric shows how many carpoolers were gained for each parking space taken at each station, as shown in Figure 4-6. One note about this metric is that it considers carpoolers traveling in both directions. That is, a single vehicle that parks at a station and takes a two-person carpool both to and from BART would add four carpooler trips per vehicle for a given day. Even more favorably, a vehicle that drops off a BART carpooler but travels on to another destination adds a BART carpooler trip without adding a parked vehicle to the station lot. However, less favorable scenarios are also possible. For example, a two-person carpool can drop off a passenger somewhere near BART, park at BART, and then drive back solo in the afternoon. This scenario adds just one carpooler per parked vehicle.

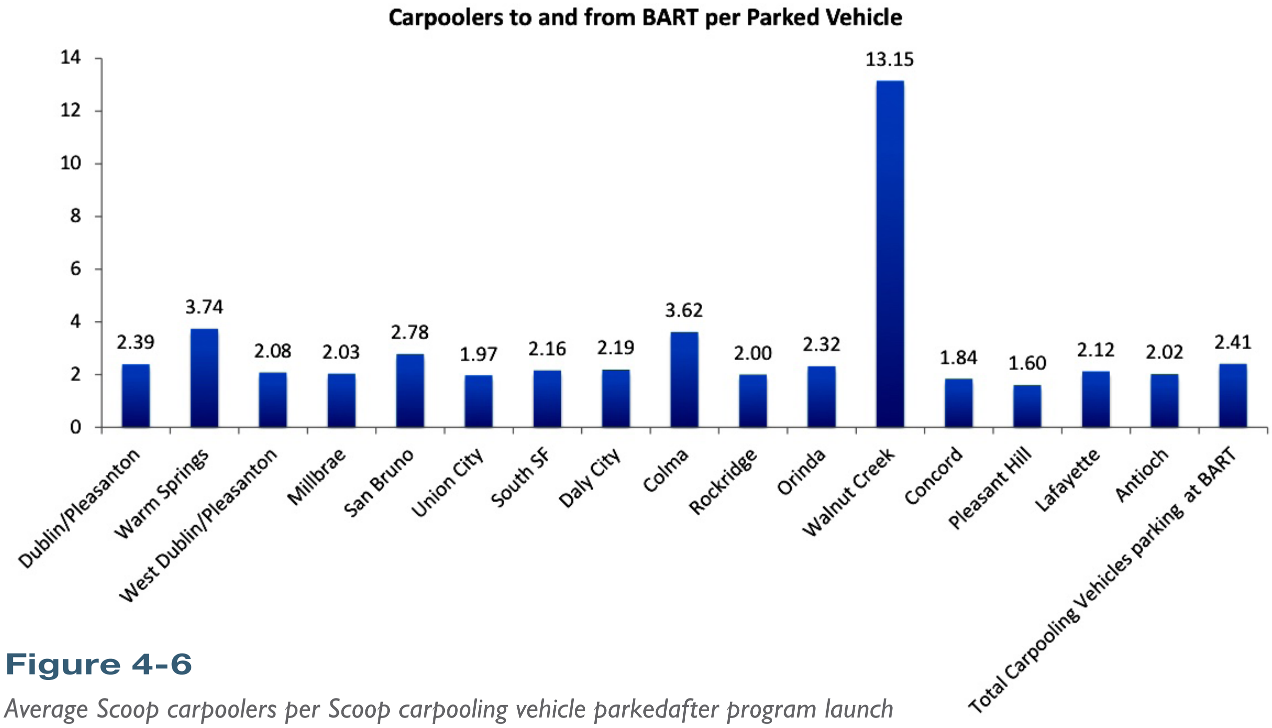


Figure 4-6

Average Scoop carpoolers per Scoop carpooling vehicle parkedafter program launch

Figure 4-6 shows that system-wide, Scoop delivered 2.41 carpooling passenger trips for every vehicle parked. This would be expected given that the most common type of carpool was a two-person carpool. But the metric also shows some variance across the system. First, 3 of the 17 stations had ratios lower than 2. This can occur if the less-favorable circumstances described above constitute a large enough share of activity. The minimum value possible is 1. Also notable is the remarkable 13.15 carpoolers per parked vehicle observed at Walnut Creek. Walnut Creek experienced the lowest total number of overall Scoop carpool trips (263), but a large share of these trips was taken likely by a single person who was dropped off at the station in the morning for many days during the evaluation period. Because drop-offs add a carpooler with no parked vehicle, and because this individual's activity comprised a large share of the Scoop carpooler travel to the station, the carpooler-to-parked-vehicle ratio was exceptional.

Parking utilization was calculated by computing the number of Scoop vehicles parked at BART as a percentage of the total lot capacity per month. This denominator was simply the total lot capacity (all parking spaces) of the station times the number of weekdays within the given month. Figure 4-7 shows the trend of BART parking lot utilization by Scoop vehicles during the evaluation period. The trends take on a shape similar to that shown in Figure 4-6. As a percent of all spaces, Scoop utilization of BART parking lots was very low. The Dublin/Pleasanton station shows the highest capacity utilization, with its minimum of 1.4% utilization, exceeding the maximum of any other station. Scoop parking utilization grew to 4% by the end of the evaluation period. For most other stations, the parking utilization of Scoop vehicles was minimal. Only in Antioch does utilization break 1% towards the end of the evaluation period. Across all Scoop BART stations, Scoop vehicles finished the evaluation period using 0.6% of monthly parking space capacity. However, the clear growth in carpooling vehicles parked at BART coupled with the lack of change in the use of the legacy lots strongly suggests a confirmation of Hypothesis 2, that utilization of parking by carpooling vehicles will increase as a result of Scoop.

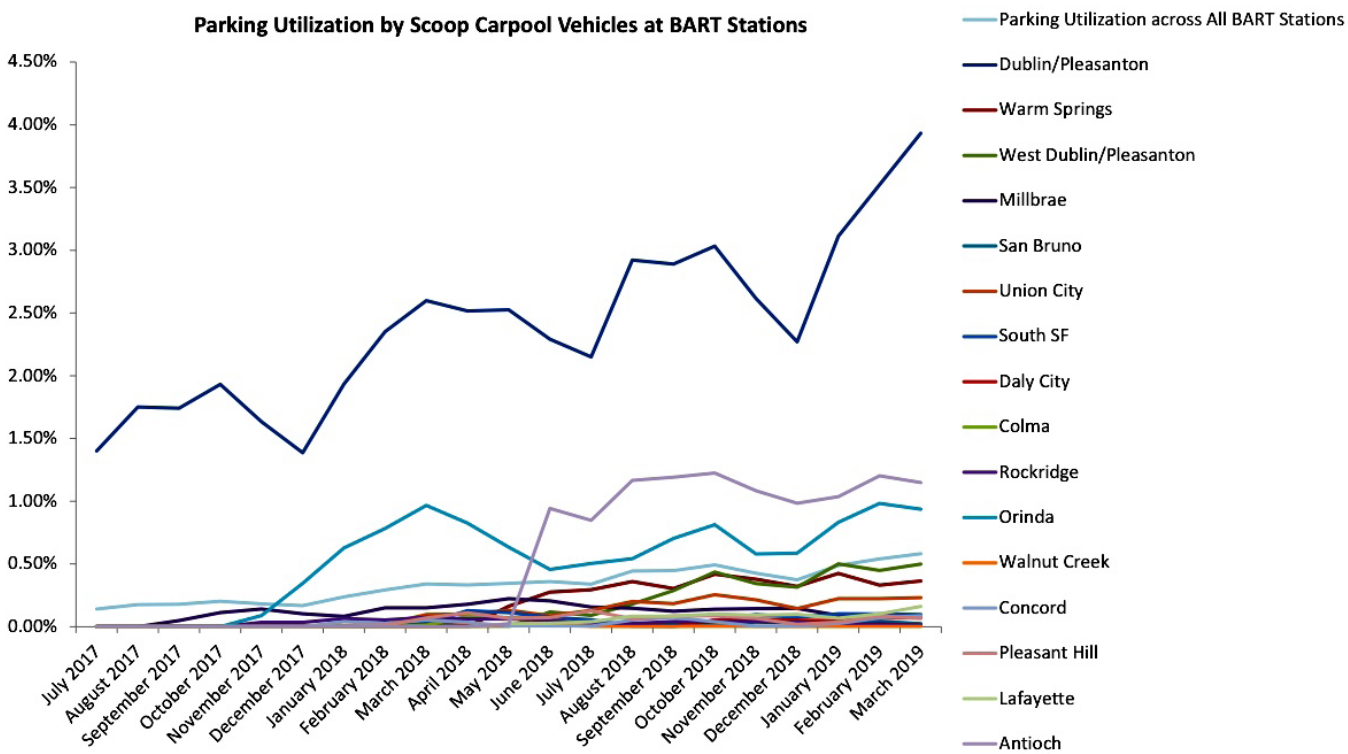


Figure 4-7

Parking utilization by Scoop carpool vehicles at BART stations

Hypothesis 3: The cost per enforcement per carpool space declined with no sacrifice in enforcement quality.

Performance Metric	Key Finding
Cost and time spent on carpool enforcement per carpool space	Cost per enforcement per carpool space declined given the large number of spaces added as a result of the program.

BART conducted its normal enforcement activities with all permit spaces. Beyond the need to check vehicle license plates against the list of Scoop carpoolers, which was updated daily, enforcement operations did not change significantly due to Scoop. The lots in which Scoop carpoolers parked already were being patrolled, and patrol operations did not change as a result of Scoop. BART did not track marginal costs of enforcement, but discussions with BART staff suggested that about one additional hour per week was needed to conduct Scoop-specific enforcement across all stations. BART reported that the loaded rate of enforcement staff was $59.16 per hour. Enforcement staff estimated that normal patrols would cover the appropriate lots within about 3.5 hours per station per day. Across the enforcement staff, this amounted to an approximate base cost of $17,600 per week. Given the estimated additional enforcement time estimated by BART, it is estimated that enforcement costs may have risen about 0.3% as a result of Scoop. At this overall cost, the cost per enforcement per carpool space would have declined given the large number of spaces that were added as a result of the program.

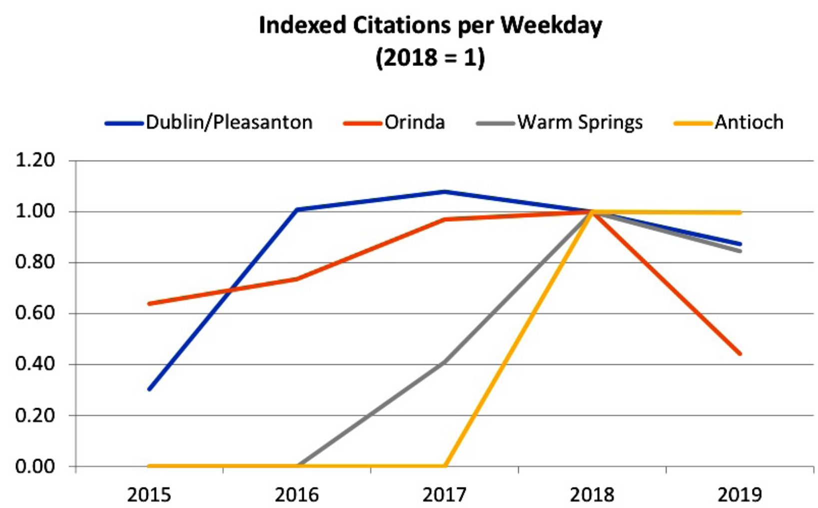
Hypothesis 4: The number of instances of illegal carpool spaces per total carpool spaces available will be lower than before the pilot initiation.

Performance Metric	Key Finding
Total number of citations given to illegal carpool vehicles over time	Available data did not enable direct evaluation of the number of carpool violations; thus, a quantified assessment of this hypothesis was indeterminable.

BART does collect citation data for permit parking lots, so data specifically on illegal carpool space use was not readily available. One challenge is that identifying fraudulent use of carpool spaces is a time-intensive process. BART engages in monitoring and enforcement operations to measure fraudulent use of carpool spaces; however, datasets describing these operations and their results are not created or are subject to restricted access. Permit citations are documented, but the specific reasons for a citation are considered restricted information due to privacy considerations. BART was able to provide aggregate permit citation data for the selected Scoop stations of Warm Springs, Orinda, Dublin/Pleasanton, and Antioch, as these stations showed the highest Scoop usage. The data do not distinguish between citations related to carpool violations and other violations that could include citations given to vehicles illegally parking in permit lots. However, the data provide some indication of the divergent trends that existed across the selected stations with respect to citations issued. The data was indexed to 1 for 2018 to illustrate the relative magnitude of citation activity across the years and normalized across stations with different levels of citation activity. These trends are presented in Figure 4-8.

Figure 4-8

Citation trends of selected stations



Of the four stations, Warm Springs and Antioch, both system termini, had the lowest citation activities. However, both stations are new to the system and, therefore, had a limited time series with respect to citations. Both show citations per day increasing with time. There are a number of reasons for an increase in citations at any station. BART noted that the enforcement team was expanded during this period, which contributed to the growth in citations. In Dublin/Pleasanton, the enforcement periods also were expanded, which contributed to the growth at that station. Citations per day notably fell in Orinda, but there was not enough information to attribute this to the Scoop to BART project. Overall, BART acknowledged that there were enforcement challenges with the permit lots that continued with the Scoop project. However, anecdotal experience suggested that fraudulent use of legacy carpool lots was considerably higher and far more difficult to enforce relative to the Scoop project. Fraudulent use of the legacy carpool lot must be identified on the spot. Permit violations with Scoop could be determined, at least partially, by a review of the daily list of license plates assigned to carpools going to BART. Overall, however, the data available did not allow for a direct evaluation of the number of carpool violations; thus, a quantified assessment of this hypothesis was indeterminable.

Hypothesis 5: The distribution of legal arrivals to carpool spaces will be closer to a uniform distribution between the hours of 6 am and 10 am than before the pilot. `

Performance Metric	Key Finding
Carpool arrival by station by hour	The Scoop to BART pilot program enabled greater travel time flexibility among carpool travelers.

One of the motivations of the Scoop pilot was to provide BART travelers with greater time flexibility in their travel to BART parking lots. The fee sections of the BART parking lots (those open to anyone) fill early in the morning, which constrains the ability of carpoolers without legacy carpool permits to arrive later in the morning and find a parking space because all available capacity is used. Legacy permits are available to anyone, but the lots are first-come/first served and fill up early with a mix of legitimate carpoolers and fraudulent users. By permitting carpoolers to access the lot any time before 10:00 AM, BART sought to enable a greater spread in carpool arrival times.

Scoop activity data did not allow an evaluation of arrival times of carpoolers to BART, as data on user travel was not directly instrumented. Rather, the data contained timestamps of the planned start time of the trip. The distribution of start time was evaluated to ascertain when Scoop users started their trip. This distribution was evaluated over time to determine whether users adapted to the greater arrival flexibility afforded by Scoop.

Figure 4-9 shows the average trip start time of carpool vehicles that parked at BART during the evaluation period. The plot shows that average trip time actually became earlier as the project progressed. This decline falls away from the center-point (8:00 AM) of the uniform distribution between 6:00 AM and 10:00 AM.

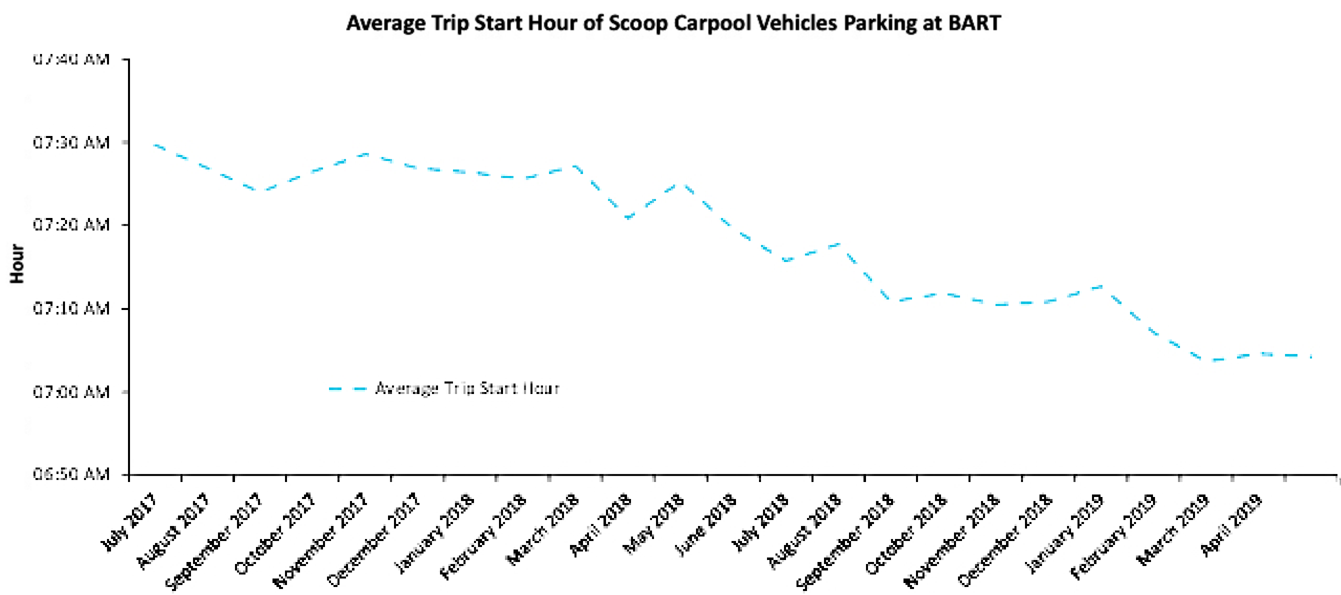


Figure 4-9

Average trip start hour of carpool vehicles parking at BART

Whereas Figure 4-9 shows a clear shift towards earlier times, the distribution of times may still tend more towards a uniform distribution if the overall spread of times increases. This, in fact, was found to happen. Table 4-1 shows the distribution of trip times and suggests that such times became more uniformly distributed during the pilot. The percentage of trip start times (system-wide) within each hour is shown for each month of the evaluation period. The rightmost column is the sum of the absolute difference of these start times from a uniform distribution across the four hours (25% within each hour). Although the average of the trip start times falls (as shown in Figure 4-9), the distribution attenuates across the hours, and this sum of absolute difference falls from 0.90 to about 0.55. The periods of 6:00–7:00 AM and 9:00–10:00 AM both show percentage gains during the evaluation period.

BART did not have data on arrivals to the legacy carpool lots before the evaluation period, and Scoop did not have arrival time data of carpool vehicles. Thus, it was not possible to determine if this distribution of arrival times was truly more uniform than the arrivals at the legacy carpool lots. However, the data presented in Figure 4-9 and Table 4-1 suggest that the distribution of trip start times within the evaluation itself became more normally distributed during the evaluation period. This does not strongly confirm the hypothesis but suggests that the Scoop pilot program enabled greater travel time flexibility among carpool travelers.

Table 4-1

Distribution of Trip Start Times of Scoop Carpool Vehicles Parking at BART

Month and Year	6:00–7:00 AM	7:00–8:00 AM	8:00–9:00 AM	9:00–10:00 AM	Sum of Absolute Difference from Uniform Distribution
July 2017	2%	54%	41%	3%	0.90
August 2017	3%	50%	42%	5%	0.84
September 2017	4%	50%	42%	5%	0.84
October 2017	3%	49%	42%	6%	0.81
November 2017	6%	45%	44%	6%	0.77
December 2017	6%	45%	43%	6%	0.76
January 2018	4%	48%	41%	7%	0.77
February 2018	5%	48%	40%	8%	0.75
March 2018	5%	49%	37%	10%	0.71
April 2018	6%	48%	37%	9%	0.71
May 2018	5%	47%	37%	11%	0.68
June 2018	10%	43%	36%	10%	0.59
July 2018	13%	45%	35%	8%	0.59
August 2018	13%	42%	36%	10%	0.55
September 2018	13%	42%	35%	9%	0.55
October 2018	13%	39%	38%	10%	0.54
November 2018	12%	40%	39%	9%	0.59
December 2018	13%	39%	40%	8%	0.58
January 2019	13%	39%	38%	11%	0.53
February 2019	13%	43%	35%	9%	0.56
March 2019	14%	45%	31%	10%	0.52
April 2019	14%	47%	31%	9%	0.55

Hypothesis 6: The number of persons per vehicle at BART stations increases after the program.

Performance Metric	Key Finding
Number of persons per vehicle parking at BART	This hypothesis could not be directly evaluated using empirical data. Based on the applied assumption, the increased occupancy of Scoop vehicles likely increased the persons per vehicle at BART stations by percentages that are above zero but less than the calculated upper bounds.

BART did not have data on broader parking at the BART station parking lots; therefore, this hypothesis could not be directly evaluated using empirical data. As shown in Figure 4-10, the number of Scoop carpoolers per vehicle parked was an average of 2.41 across the system. Because most vehicles parking at BART station parking lots carried only one person per vehicle, the addition of Scoop vehicles at these higher occupancies likely increased the average vehicle occupancy slightly. Scoop carpool vehicles occupied 0.61% of spaces at the end of evaluation period, indicating that the program's overall impact, on average, occupancy was small.

The hypothesis can be partially evaluated if the assumption that BART parking lots fill to capacity with SOVs is applied, except for Scoop vehicles. Empirically, this is not verifiable, but the assumption is supported by the general knowledge that most of the parking at BART stations is SOVs. By applying what is known of Scoop carpooling activity in terms of carpoolers and vehicles parked, it can be estimated that the percentage change in persons per vehicle that would result from Scoop activity. The trends derived from this assumption are shown by station in Figure 4-6.

Figure 4-10 shows that the monthly activity of Scoop would have increased the persons per vehicle parked by 5% at the Dublin/Pleasanton station, but by closer to 1% or less at the other stations. Across all Scoop to BART stations, system activity is estimated to have increased the persons per parked vehicle by 0.81% at the end of the evaluation period. These values are inevitably an upper bound, because they assume that all non-Scoop vehicles had occupancy of one. Although this is a good assumption for most vehicles parked at BART, there are inevitably some vehicles in the legacy, fee, and permit lots that had higher occupancies. Hence, the increased occupancy of Scoop vehicles likely increased the persons per vehicle at BART stations by percentages that are above zero but less than the upper bounds defined by the assumption applied here.

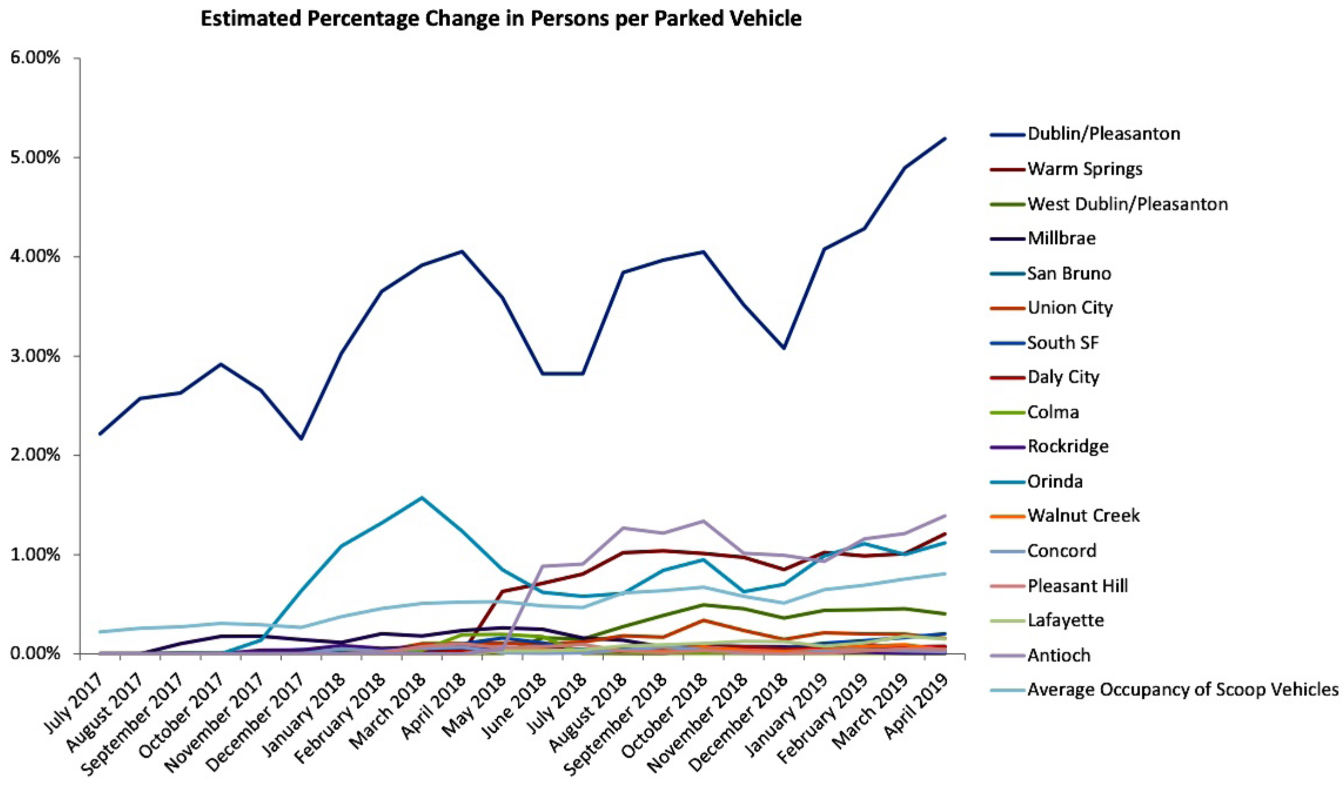


Figure 4-10

Estimated percentage change in persons per parked vehicle

Hypothesis 7: The technological changes to carpooling have caused people who would have driven alone to carpool to BART stations.

Performance Metric	Key Finding
Estimated total number of people who would drive alone to work without project	A large share of respondents reported a shift from driving alone to Scoop, strongly suggesting that Scoop enabled a significant share of users who would have opted to drive alone to BART to carpool instead.

The survey administered to Scoop users was used to evaluate a number of behavioral changes that could be engendered by the availability of the Scoop to BART program. To better understand mode shift, the survey asked respondents about how they would have traveled in the absence of Scoop. One question probing this shift focused on the most recent trip made with Scoop. In this context, respondents were asked how they would have made the trip to or from BART had Scoop not been available. Figure 4-11 presents the distribution of responses to this question.

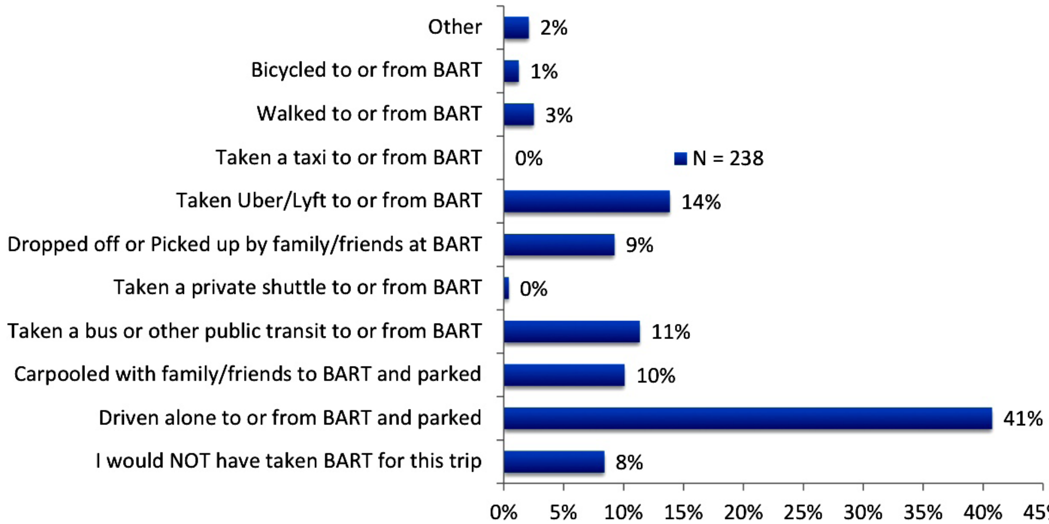


Figure 4-11

Mode substitution as a result of scoopresulting from Scoop activity

The distribution of responses shows that a significant portion of respondents would have driven alone to BART in the absence of Scoop. Notably, 41% of respondents indicated that if Scoop was not available, they would have driven alone to or from BART, 14% indicated that they would have taken Uber or Lyft, and 9% reported that someone would have had to come pick them up, which would also constitute extra VMT. Taken together, more than half of respondents indicated that Scoop was substituting for travel in a personal SOV. Other mode substitutions reported included public transit (11%) and carpooling with family/friends (10%). The large share of respondents reporting a shift from driving alone to Scoop strongly suggests that Scoop enabled a significant share of users who would have opted to drive alone to BART to carpool instead.

Hypothesis 8: The expansion of Scoop to all BART stations will lower VMT and reduce GHG emissions that would have occurred in its absence.

Performance Metric	Key Finding
Measured travel behavior change and estimated emissions change	Given the notable shift of users away from SOV trips, the results of this numerical experiment and the findings of the survey suggest the Scoop to BART program reduced net VMT.

The survey asked questions about changes in driving and other behavior that resulted from the use of Scoop. Figure 4-12 shows the distribution of responses to the general direction of change in personal driving. Respondents were asked if they felt their driving had increased, decreased, or otherwise remained unchanged as a result of Scoop.

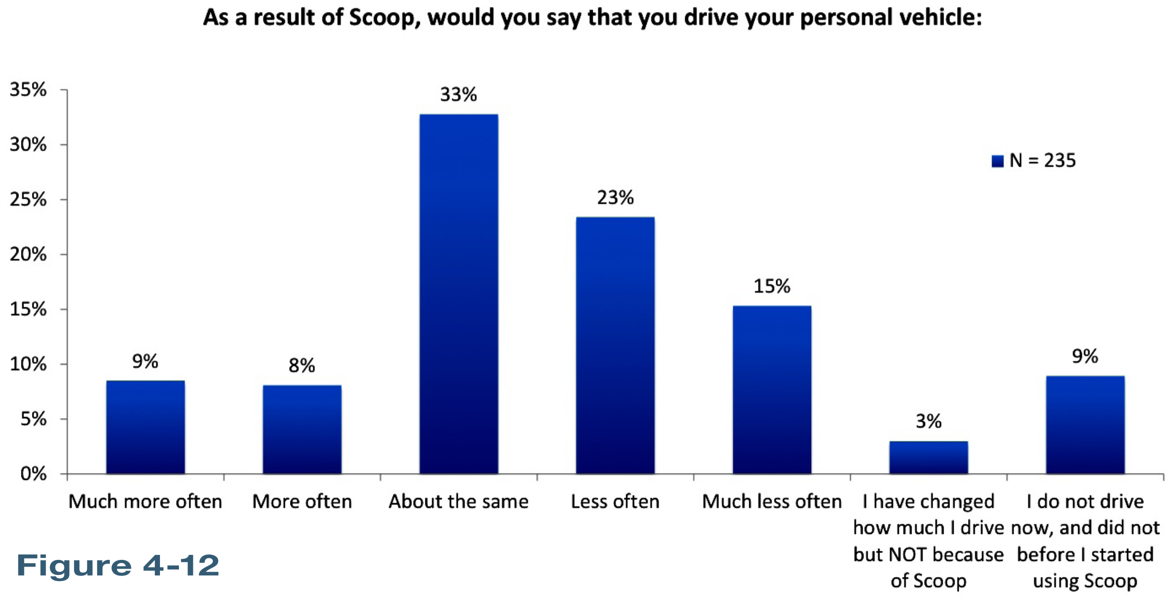


Figure 4-12

General change in personal vehicle driving

The distribution of responses shows that 38% of respondents reported that they drove less often as a result of Scoop, whereas 17% of respondents reported driving more. The Scoop activity data also provided shared distance traveled across all carpool trips. This distance was an estimate of the distance traveled when two or more carpoolers were in the same car, a measure of the joint distance traveled. Figure 4-13 shows the trend of total shared miles to or from BART from July 2017 to April 2019.

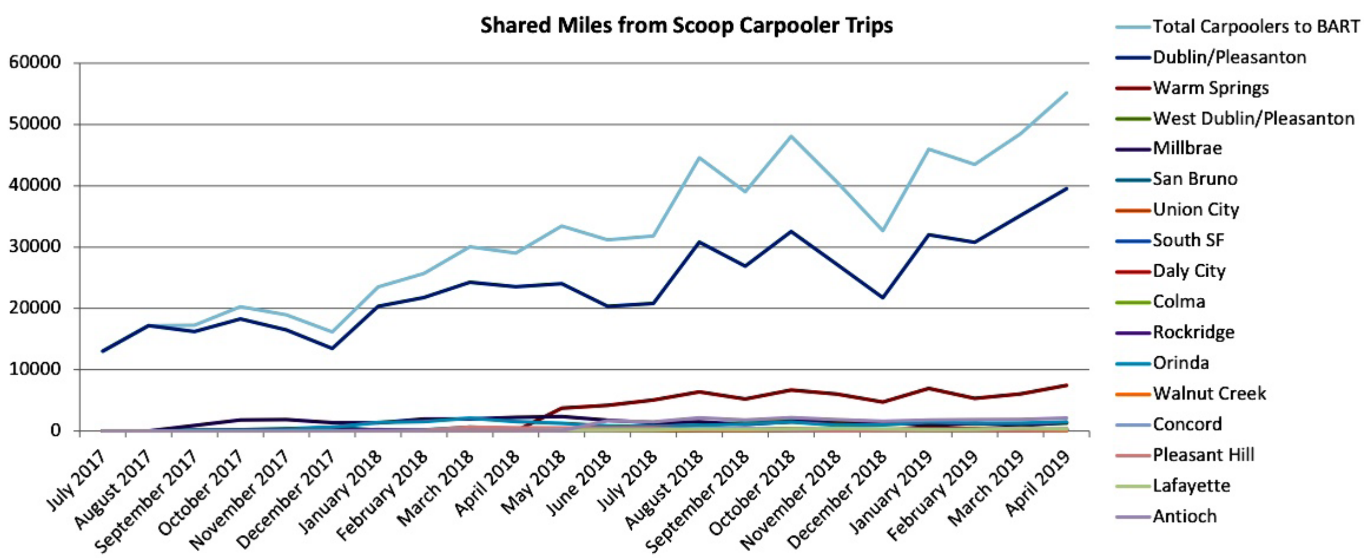


Figure 4-13

Trend in total shared miles by carpooler

For three-person carpools, the shared distance of the trip was multiplied by 2 to account for the two riders in the vehicle. The raw sum of shared trip distances is an estimation of the total miles traveled with an additional person in the vehicle. The cumulative sum of shared miles during the period of Figure 4-13 is about 706,000 miles. This number is most likely an upper bound of VMT reduction due to the dynamics of mode shift. For example, if two Scoop users formerly accessed BART by bus, walking, or bicycle, then a shift to jointly carpooling with Scoop would actually constitute an increase in VMT. If a bus rider joins a driver who would have driven anyway, then the shared miles do not constitute an increase in VMT but also would not constitute a decrease in VMT. If the rider would have driven alone or used a personal vehicle service such as a TNC or taxi, the shared miles would represent a true reduction in the VMT.

The estimated direction of shared mile impacts depends, in part, on the combination of who is in the vehicle and how their modes shifted as a result of Scoop. The main mode shifts that matter are SOV shifts (including TNCs) and non-SOV shifts (e.g., transit, non-motorized modes, induced travel, etc.). These combinations and their implication for the calculated direction of VMT shift is summarized as follows:

- **Scenario 1** – Carpool with non-SOV shift and non-SOV shift = shared-miles increase VMT (e.g., two people stop riding the bus, and drive together).
- **Scenario 2** – Carpool with SOV shift and non-SOV shift = shared-miles impose zero VMT change (e.g., a bus rider gets in a car that is going to BART anyway, but gains the carpooling benefits).
- **Scenario 3** – Carpool with SOV shift and SOV shift = shared-miles reduce VMT (e.g., 2 people would have driven, but only one of them is).

Ultimately, it is the count of people shifting from SOVs that matter. For three-person carpools, if no one is shifting from an SOV, Scenario 1 applies. If one person is shifting from an SOV, Scenario 2 applies. If two people are shifting from SOVs, but the third person is not, then Scenario 3 applies as if the carpool is a two-person carpool (e.g., the shared miles is not doubled). Naturally, if all three people in a three-person carpool are shifting from SOVs, then the shared miles should be doubled to estimate reduced VMT.

A limitation of activity data is that it does not come with variables defining definitive behavioral change. This is where surveys are required and, for an aggregate estimate of VMT change, a merging of survey data and activity data is required. The data in Figure 4-11 show that roughly 64% of respondents would have implemented some form of SOV shift had Scoop been unavailable for their most recent trip. If the remaining 36% were assumed to engage in some form of non-SOV shift, then a rough estimate of the resulting change in VMT can be generated to address the hypothesis.

To generate a rough estimate of the likely direction of VMT change, riders were randomly assigned a mode shift within the dataset based on the odds described above. Based on those random assignments, mode shift combinations were generated for each trip in the dataset. The mode shift combinations were then used to generate directions of VMT change based on the scenarios outlined above. Based on the assigned direction of VMT change, the shared distance of travel was then calculated as either an increase in VMT (Scenario 1), a zero net change in VMT (Scenario 2), or a decrease in VMT (Scenario 3). The net change in VMT was summed across all vehicle trips. These random assignments were repeated multiple times to check for robustness and sensitivity of the overall VMT change to redistributions of individual mode shift. Repeated experiments found that given these parameters and assignments, about 44% of trips were reducing VMT due to SOV substitution, 44% were exhibiting no change in VMT, and the remaining 12% were increasing VMT. This distribution remained relatively stable with repeated random assignments of mode shift to individual trips. Given the notable shift of users away from SOV trips, the results of this numerical experiment and the findings of the survey suggest the Scoop to BART program was reducing net VMT.

Hypothesis 9: Overall ridership increases as a result of the Scoop program.

Performance Metric	Key Finding
Ridership at all stations over time	Although the analysis of ridership data could not identify an impact of Scoop within the broader BART ridership levels, the survey responses strongly suggested that a sizeable minority of individuals using Scoop had increased their BART use as a result of the program, thus increasing BART ridership.

Scoop impacts on ridership were explored through survey data and an analysis of BART ridership data. In the survey, respondents were asked about their ridership of BART before using Scoop and currently and if Scoop had caused an increase in their ridership of BART. Figure 4-14 shows the distribution of response to before and after usage of BART since using Scoop, indicating a general shift toward greater usage of BART since using Scoop; 38% of respondents reported using BART five days per week before Scoop and 49% reported using it five days per week currently. The general shift towards more frequent utilization of BART is evident in Figure 4-14.

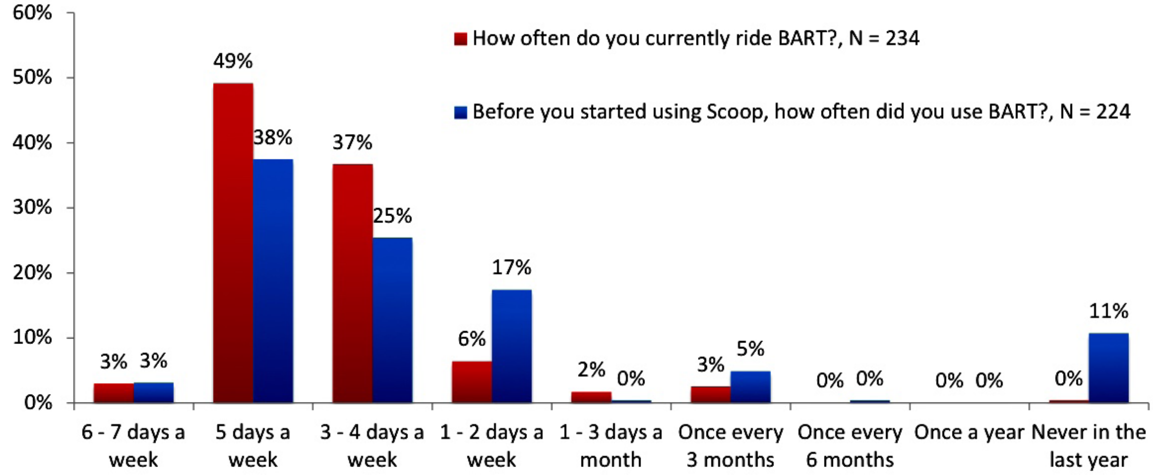


Figure 4-14

Use of BART before and after using Scoop

Figure 4-15 shows responses to a similar question related to use of BART. Whereas Figure 4-14 shows a before and after measurement, Figure 4-15 required the respondent to attribute this change to Scoop. The results show that 41% indicated that they used BART more often as a result of Scoop and only 2% reporting that they used BART less often as a result. The survey responses strongly suggest that the population of Scoop users, on balance, increased their use of BART and that this increase was a result of Scoop.

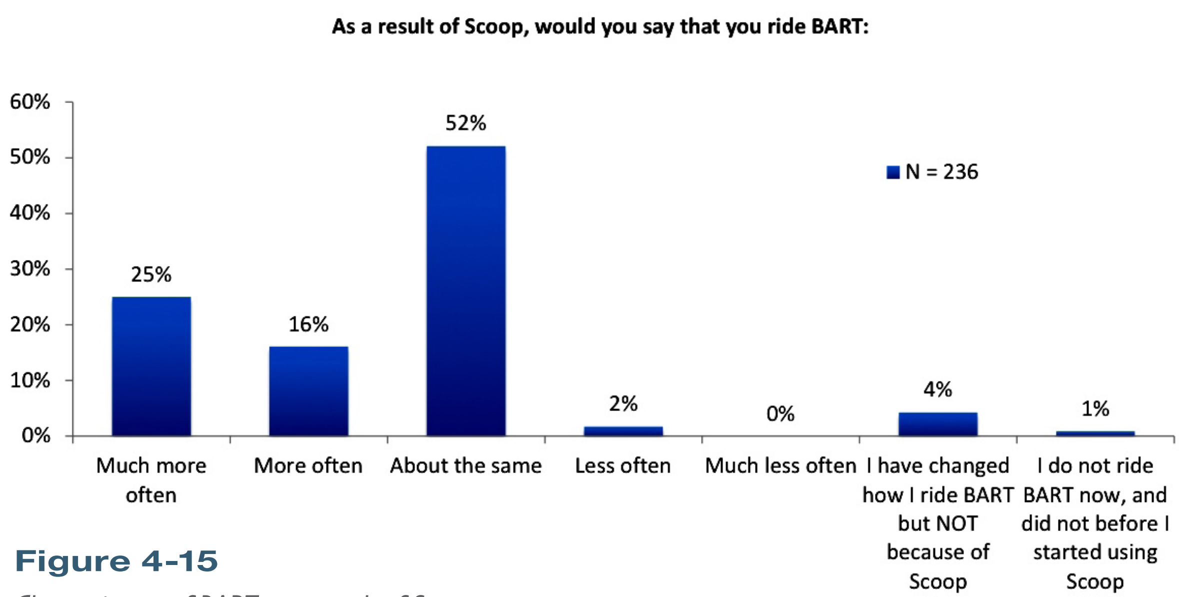


Figure 4-15

Change in use of BART as a result of Scoop

The evaluation team also sought to evaluate whether the increase in BART usage from Scoop was detectable in the ridership data. To determine this, a model was used to evaluate whether the presence of the Scoop to BART program could be isolated in ridership time series data. Findings indicate that the impact of Scoop was not large enough to be visible within the large fluctuations of ridership activity with the BART system.

To execute this analysis, the ridership time series of every station was used to calculate a linear ridership trend as a function of 1) time, 2) a dummy variable for every month of the year, and 3) a dummy Scoop activity variable. Each variable was assigned a value of 1 or 0 according to the given program implementation dates. It should be noted that the Scoop program at Antioch station was implemented when the station first opened; thus, ridership data before implementation was not available, and the influence of Scoop could not be evaluated. If the estimated Scoop activity coefficient was statistically significant, then the impacts of Scoop would be visible in the ridership data.

The following equation shows the applied trend equation:

$$Ridership_{i,t} - \beta_0 + \beta_1 Time + \beta_2 Jan + \beta_3 Feb + \beta_4 Mar + \beta_5 Apr + \beta_6 May + \beta_7 June + \beta_8 July + \beta_9 Aug \\ + \beta_{10} Sep + \beta_{11} Oct + \beta_{12} Nov + \beta_{13} Scoop\ Activity_{i,t}$$

where:

- I = station (1, 2, …, 17)
- Time = time trend variable (1, 2, …, 54)
- Dummy variables: Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, and Scoop activity

Table 4-2 summarizes the results of the estimated linear model, including coefficient estimates and their P-values in addition to the adjusted R^2 of the model. All Scoop activity coefficients were insignificant except for Walnut Creek and North Concord; however, both stations had negative coefficients, which is counter to the intuition that ridership would increase or otherwise remain the same due to the Scoop program. Only Lafayette, Orinda, Daly City, Colma, and Dublin/Pleasanton had positive but insignificant Scoop activity coefficients.

To understand the reason behind the negative Scoop activity coefficients, ridership was analyzed at smaller intervals of 30 and 60 days before and after Scoop program implementation. According to Table 4-3, Walnut Creek station had an increase in ridership 30 days and 60 days after the program, although its estimated coefficient was significant and negative. However, North Concord station showed a decrease in ridership. To test the significance of the changes in ridership, a paired t-test was conducted for the 17 stations, as shown in

Table 4-3, which also includes summary statistics of ridership six months before and after program implementation. Both t-tests showed that the change in ridership was insignificant.

Another approach applied to assess the influence of Scoop activity on ridership was to calculate average ridership in specific time intervals before and after Scoop program implementation dates. In this case, a paired t-test was applied for each station, as shown in Table 4-4. The results show that Union City, Lafayette, Colma, South San Francisco, and Warm Springs stations had significant increases in ridership after the implementation of the Scoop program. However, Rockridge, North Concord, and San Bruno stations had significant decreases in ridership.

The broad conclusion of the statistical analysis of BART ridership was that movements in ridership were large enough and subject to unobserved exogenous variables that were significant enough to confound any isolation of Scoop's contribution to station ridership. To put this in context, ridership at the station with the largest Scoop ridership was Dublin/Pleasanton, which, at the peak of the project, was generating a little more than 6,000 Scoop trips per month. Ridership at the Dublin/Pleasanton station would regularly shift by magnitudes far larger, an average change of 15,000 per month, washing out any visible contribution of Scoop. Other stations at which activity ranged in the hundreds or less simply did not have enough activity to be econometrically identifiable. It is possible that a model could be developed with greater specificity or detail to isolate these impacts. Whereas the analysis of ridership data could not identify an impact of Scoop within the broader BART ridership levels, the survey responses strongly suggested that a sizeable minority of individuals using Scoop had increased their BART use as a result of the program, thus increasing BART ridership.

Table 4-2

Results of Estimated Linear Model

Station	Coefficient Estimate														Adjusted R^2
	0	Time	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	0	
	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9	β_{10}	β_{11}	β_{12}	β_{13}	
Union City	90992 (0)	-146 (0.07)	8832 (0.01)	8390 (0.02)	22477 (0)	17808 (0)	19359 (0)	20724 (0)	13242 (0)	23360 (0)	17587 (0)	20976 (0)	6282 (0.09	-282 (0.92)	0.6
Concord	120347 (0)	-327 (0)	6805 (0.1)	7076 (0.09)	24959 (0)	18896 (0)	20610 (0)	19669 (0)	12221 (0.01)	26660 (0)	18528 (0)	22304 (0)	5587 (0.2	-962 (0.77	0.71
Pleasant Hill	132350 (0)	227 (0.11)	13660 (0.02)	10843 (0.06)	32293 (0)	24640 (0)	26740 (0)	26308 (0)	18718 (0)	36777 (0)	23333 (0)	29584 (0)	8119 (0.17)	-2276 (0.61)	0.59
Walnut Creek	129298 (0)	-40 (0.68)	5712 (0.24)	1983 (0.68)	21597 (0)	14621 (0)	18282 (0)	22759 (0)	16499 (0)	31024 (0)	16152 (0)	19633 (0)	1470 (0.77)	-6461 (0.07)	0.62
Lafayette	71132 (0)	-217 (0)	3213 (0.19)	1324 (0.58)	12255 (0)	8783 (0)	10901 (0)	12312 (0)	7500 (0.01)	14530 (0)	7897 (0)	9565 (0)	-164 (0.95)	2832 (0.11)	0.69
Orinda	55167 (0)	2 (0.97)	3298 (0.13)	1094 (0.61)	9662 (0)	6049 (0.01)	8980 (0)	10377 (0)	7205 (0)	12626 (0)	7758 (0)	9384 (0)	367 (0.87)	47 (0.98)	0.58
Rockridge	108234 (0)	-251 (0.01)	3876 (0.3)	3657 (0.33)	19433 (0)	13973 (0)	16391 (0)	21453 (0)	14960 (0)	22547 (0)	13126 (0)	17529 (0)	2363 (0.55)	41 (0.99)	0.68
Daly City	184858 (0)	-294 (0.05)	-6061 (0.37)	17644 (0.01)	35570 (0)	35246 (0)	26794 (0)	8922 (0.19)	182 (0.98)	28844 (0)	39297 (0)	44378 (0)	9901 (0.17)	1141 (0.82)	0.73
Colma	88020 (0)	-194 (0.01)	5975 (0.07)	5190 (0.11)	18028 (0)	13242 (0)	14755 (0)	15709 (0)	9449 (0.01)	19118 (0)	11675 (0)	15092 (0)	3109 (0.36)	589 (0.81)	0.63
Dublin/ Pleasanton	140047 (0)	230 (0.15)	9003 (0.14)	7082 (0.24)	31208 (0)	28656 (0)	30705 (0)	36358 (0)	28118 (0)	47603 (0)	27465 (0)	29352 (0)	4457 (0.47)	40 (0.99)	0.71
North Concord	53699 (0)	-79 (0.18)	3335 (0.25)	2891 (0.32)	13297 (0)	8636 (0)	9865 (0)	8403 (0.01)	4928 (0.11)	11046 (0)	7599 (0.02)	9334 (0)	2322 (0.45)	-10530 (0)	0.69
South San Francisco	67443 (0)	-32 (0.66)	4499 (0.19)	5992 (0.08)	16997 (0)	12318 (0	13470 (0)	14240 (0)	9027 (0.02)	16366 (0)	10414 (0.01)	13332 (0)	3142 (0.38)	-3916 (0.13)	0.49
San Bruno	73651 (0)	-115 (0.1)	3183 (0.25)	3100 (0.26)	13632 (0)	8984 (0)	10032 (0)	11825 (0)	7553 (0.01)	15274 (0)	8776 (0)	11594 (0)	1552 (0.59)	-1660 (0.46)	0.61
Millbrae	131857 (0)	-254 (0.05)	7121 (0.16)	8925 (0.08)	26802 (0)	16425 (0)	20150 (0)	27310 (0)	19580 (0)	30952 (0)	19145 (0)	24246 (0)	4903 (0.36)	-2724 (0.51	0.65
West Dublin/ Pleasanton	65591 (0)	-51 (0.28)	3716 (0.12	2546 (0.29)	13417 (0)	10605 (0)	11368 (0)	13359 (0)	9059 (0)	17727 (0)	9381 (0)	10843 (0)	1091 (0.66)	-459 (0.79)	0.68
Warm Springs	30427 (0)	2378 (0)	10126 (0.3)	3431 (0.72)	384 (0.97)	12154 (0.18)	18935 (0.05	16898 (0.07)	15201 (0.14)	24057 (0.03)	11475 (0.25)	23364 (0.03)	10231 (0.3)	-12111 (0.16)	0.69
Antioch	32961 (0.52)	2227 (0.53)	6041 (0.91)	-1225 (0.98)	2363 (0.96	4550 (0.93)	-12792 (0.78)	7936 (0.86)	19257 (0.73)	23827 (0.67)	13425 (0.8)	20642 (0.7)	7157 (0.89)	N/A	-2.99

Table 4-3

Paired t-Test Results and Summary Statistics of Ridership

Station	Scoop Date	Ridership (pax)		Index		Ridership (pax)		Index		Ridership 6 months Before & After Scoop (pax)			
		30 Days Before Scoop	30 Days After Scoop	30 Days Before Scoop	30 Days After Scoop	60 Days Before Scoop	60 Days After Scoop	60 Days Before Scoop	60 Days After Scoop	Average	Standard Deviation	Minimum	Maximum
Union City	2/12/2018	98,143	103,716	1	1.06	91,439	102,450	1	1.12	104,210	7,642	84,735	110,674
Concord	10/23/2017	125,542	118,743	1	0.95	133,291	113,166	1	0.85	124,545	9,533	107,589	141,040
Pleasant Hill	10/23/2017	158,830	150,994	1	0.95	169,477	144,569	1	0.85	160,144	11,938	138,143	180,123
Walnut Creek	5/14/2018	137,881	144,396	1	1.05	140,979	143,040	1	1.01	138,237	10,013	121,401	155,356
Lafayette	5/7/2018	69,710	72,746	1	1.04	71,635	71,913	1	1	69,676	5,942	60,637	78,533
Orinda	11/13/2017	62,876	54,303	1	0.86	61,940	57,843	1	0.93	61,960	4,749	54,303	69,149
Rockridge	11/13/2017	115,669	98,715	1	0.85	112,667	103,193	1	0.92	112,177	8,268	98,715	124,800
Daly City	3/26/2018	185,176	203,930	1	1.1	180,998	203,010	1	1.12	193,576	14,259	169,607	213,903
Colma	3/26/2018	84,265	92,964	1	1.1	87,092	95,770	1	1.1	91,302	5,951	80,236	101,349
Dublin/ Pleasanton	1/23/2017	147,712	152,460	1	1.03	151,080	168,707	1	1.12	169,315	15,048	147,712	193,347
North Concord	5/21/2018	60,288	48,863	1	0.81	60,955	47,775	1	0.78	52,569	6,296	41,318	61,621
South San Francisco	3/26/2018	68,914	74,383	1	1.08	71,203	76,385	1	1.07	73,719	4,508	64,794	80,452
San Bruno	9/12/2017	84,975	77,645	1	0.91	78,298	74,188	1	0.95	75,718	6,406	66,411	84,975
Millbrae	9/12/2017	156,291	142,867	1	0.91	144,309	135,785	1	0.94	137,974	12,337	118,875	156,291
West Dublin/ Pleasanton	6/4/2018	78,270	75,170	1	0.96	76,165	79,530	1	1.04	71,933	7,504	58,812	83,889
Warm Springs	5/1/2018	68,937	75,165	1	1.09	70,286	73,817	1	1.05	71,853	10,051	55,383	93,709
Antioch	5/29/2018	N/A	59,839	N/A	N/A	N/A	59,369	N/A	N/A	N/A	N/A	N/A	N/A
Average		**106,497**	**102,759**	**1**	**0.98**	**106,363**	**102,971**		**0.99**	**106,807**	**8,778**	**91,792**	**120,576**
		Paired t-test		*0.28*		*Paired t-test*		*0.38*					

Table 4-4

Paired t-Test Results for Ridership at 90 / 120 / 150-Day Intervals

Station	Scoop Date	Average Ridership (pax)						t-test (P-value)		
		90 Days Before Scoop	90 Days After Scoop	120 Days Before Scoop	120 Days After Scoop	150 Days Before Scoop	150 Days After Scoop	Before/ After 90 Days	Before/ After 120 Days	Before/ After 150 Days
Union City	2/12/2018	91,824	104,273	95,013	104,380	95,610	103,885	0.01	0.08	0.06
Concord	10/23/2017	126,883	115,611	128,444	115,428	129,710	118,466	0.21	0.01	0.1
Pleasant Hill	10/23/2017	162,124	149,672	164,086	149,798	165,454	154,181	0.24	0.01	0.16
Walnut Creek	5/14/2018	136,271	147,145	137,189	143,151	134,985	144,288	0.12	0.15	0.13
Lafayette	5/7/2018	68,930	74,119	68,343	72,636	66,802	73,757	0.15	0.06	0.06
Orinda	11/13/2017	64,343	57,297	62,891	59,041	63,839	59,380	0.13	0.07	0.15
Rockridge	11/13/2017	116,711	102,690	114,229	106,232	116,162	107,026	0.09	0.06	0.11
Daly City	3/26/2018	177,201	195,081	179,838	191,371	186,651	194,600	0.14	0.13	0.11
Colma	3/26/2018	84,807	95,400	85,184	94,355	87,097	95,754	0.01	0.03	0.04
Dublin/ Pleasanton	1/23/2017	155,763	167,203	161,801	171,198	168,110	174,458	0.23	0.27	0.34
North Concord	5/21/2018	58,535	48,953	58,090	48,006	56,440	48,777	0.04	0.01	0.03
South San Francisco	3/26/2018	69,066	75,883	69,134	75,198	70,927	76,248	0.02	0.05	0.08
San Bruno	9/12/2017	79,846	71,596	80,395	71,863	78,399	71,122	0.13	0.01	0.1
Millbrae	9/12/2017	147,497	130,148	147,469	130,487	143,225	129,171	0.12	0.02	0.11
West Dublin/ Pleasanton	6/4/2018	76,264	76,694	73,598	77,263	72,931	74,252	0.47	0.15	0.41
Warm Springs	5/1/2018	67,231	76,703	66,881	75,501	64,581	79,143	0.08	0.01	0.02
Antioch	5/29/2018	N/A	61,477	N/A	61,783	N/A	61,783	N/A	N/A	N/A
Average		**105,206**	**102,938**	**105,787**	**102,805**	**106,308**	**103,899**			

Hypothesis 10: Users of the Scoop application reduce their cost of travel relative to their previous method of travel to BART or commuting.

Performance Metric	Key Finding
Cost of travel by users prior to Scoop	Although data available did not permit an activity-based analysis of cost impacts to the user, survey results indicated that a sizable minority felt that Scoop was lowering the cost/ net cost of travel to BART.

One of the motivations of the Scoop program was to provide users with an ability to access BART at a reduced cost relative to other options available. Origin and destination information was not available within the activity data provided by Scoop, which made an activity-based analysis of user cost infeasible.

However, the survey did ask questions about the reason why the respondent was taking Scoop to or from BART. Figure 4-16 shows the distribution of responses to the check-all-that-apply question, indicating that 40% of respondents reported that Scoop was cheaper than the alternative option available, and 30% believing that they could offset their travel cost by driving with Scoop.

Although the data available did not permit a more detailed analysis of cost impacts to the user, the results of the survey indicated that a sizable minority felt that Scoop was lowering the cost/net cost of travel to BART.

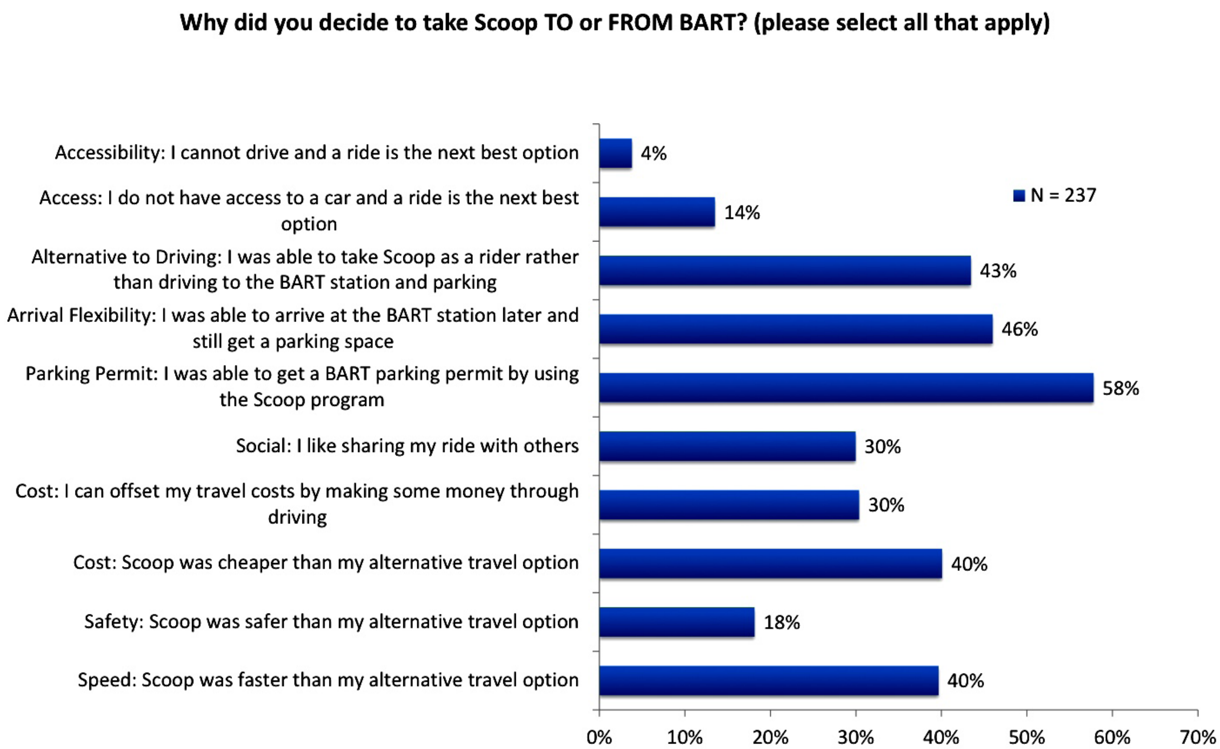


Figure 4-16

Reason for Taking Scoop to or from BART

Hypothesis 11: Enforcement and abuse of Scoop permits are low, with a fraud rate less than 5%.

Performance Metric	Key Finding
Measured fraud rate of Scoop permits	BART enforcement believed that fraud declined as a result of Scoop, but quantified measurement was difficult.

BART did not have information on fraud and abuse of Scoop permits. An advantage of Scoop is that the ability of users to commit fraud (pretending to carpool to gain parking advantages) is limited because Scoop requires a match with a rider or driver. Without a match, the license plate of the driver's vehicle would not be on the daily updated list. Getting on this list was difficult to fake because another person was assigned to the carpool and users had little to no control regarding with whom they were matched. However, BART enforcement and program management staff believed that it was possible to “game the system.” They considered enforcement to be far easier than with legacy carpool spaces, where no record of an actual carpool was required (or possible) beyond a permit. However, BART did not have a data on enforcement activities , and measurement of fraud was also complicated because some users could be legitimate carpools but appear to be fraudulent if they were matched with a rider who was dropped off before arriving at BART. BART’s enforcement experience suggested that fraudulent use of legacy carpooling lots was as high as 60%, whereas fraudulent use of Scoop was no higher than 30%, likely closer to 15% or less.

Hypothesis 12: The marginal cost for BART for implementing the program is less than the revenue earned from additional ridership.

Performance Metric	Key Finding
Estimated revenue gain from ridership increaases and parking exceed the marginal cost incurred by BART to implement the Scoop program	It is inconclusive as to whether the ridership revenue gained by the additional ridership enabled by Scoop exceeded the marginal costs of implementing the project.

As revenue and ridership are directly correlated, this hypothesis was evaluated in a way similar to Hypothesis 9. Total origin revenue was calculated for each of the 17 BART stations over the study period by multiplying each origin/destination ridership with its corresponding fare table from the corresponding year. In addition, a second approach was applied by calculating the average revenue over specific time intervals before and after the Scoop to BART program implementation dates. In this case, a paired t-test was applied for each station, as shown in Table 4-5. Union City, Lafayette, Colma, South San Francisco, and Warm Springs stations had significant increases in revenue after implementation of the Scoop program, and North Concord had a significant decrease in revenue.

Broadly, the findings of the empirical analysis of ridership and fare data followed from the findings of Hypothesis 9, in that Scoop appeared to have a positive impact on ridership. Thus, it follows that additional revenue was obtained from this increase. However, changes in revenue were not observed by station in a way that could be systematically attributed to Scoop. Scoop activity indicated the BART access station but not the BART destination as required to calculate fare. Frequency of individual use also was not observed. These and related challenges made the evaluation of this hypothesis indeterminable. Thus, it is inconclusive if the ridership revenue gained by the additional ridership enabled by Scoop exceeded the marginal costs of implementing the project.

Table 4-5

Paired t-Test Results for Revenue at 90 / 120 / 150-day Intervals

Station	Scoop Date	Average Revenue ($)						t-test (P-value)		
		90 Days Before Scoop	90 Days After Scoop	120 Days Before Scoop	120 Days After Scoop	150 Days Before Scoop	150 Days After Scoop	Before/ After 90 Days	Before/ After 120 Days	Before/ After 150 Days
Union City	2/12/2018	451,326	522,243	464,945	522,269	467,833	520,044	0.01	0.05	0.03
Concord	10/23/2017	638,747	587,508	646,759	588,218	652,338	605,615	0.24	0.01	0.15
Pleasant Hill	10/23/2017	814,538	759,565	824,224	762,580	831,007	787,213	0.28	0.02	0.23
Walnut Creek	5/14/2018	662,757	721,127	666,703	700,963	653,001	706,073	0.11	0.13	0.11
Lafayette	5/7/2018	324,093	349,428	321,235	342,060	312,655	347,230	0.15	0.07	0.06
Orinda	11/13/2017	272,636	247,942	266,886	256,487	271,009	258,516	0.18	0.17	0.25
Rockridge	11/13/2017	440,777	392,081	431,680	406,579	438,870	410,435	0.11	0.1	0.16
Daly City	3/26/2018	703,414	775,090	713,259	754,971	740,638	766,486	0.2	0.21	0.11
Colma	3/26/2018	334,803	380,736	334,876	376,675	341,511	382,471	0.01	0.03	0.03
Dublin/ Pleasanton	1/23/2017	895,194	962,848	929,467	986,315	965,811	1,004,350	0.23	0.26	0.33
North Concord	5/21/2018	331,596	275,055	328,984	269,686	318,293	273,850	0.04	0.01	0.03
South San Francisco	3/26/2018	289,922	321,892	289,149	319,276	295,939	323,990	0.02	0.05	0.05
San Bruno	9/12/2017	357,740	320,233	359,876	323,620	351,111	321,459	0.13	0.01	0.12
Millbrae	9/12/2017	695,580	612,587	695,096	617,979	675,299	613,703	0.11	0.02	0.12
West Dublin/ Pleasanton	6/4/2018	426,964	427,247	412,035	431,272	408,083	414,877	0.5	0.15	0.42
Warm Springs	5/1/2018	406,963	461,889	404,739	453,813	389,133	471,150	0.07	0.02	0.02
Antioch	5/29/2018	N/A	423,608	N/A	425,804	N/A	425,804	N/A	N/A	N/A
Average	**502,941**	**502,416**	**505,620**	**502,269**	**507,033**	**507,839**				

Hypothesis 13: The process of deploying the project will produce lessons learned and recommendations for future research and deployment.

Performance Metric	Key Finding
Lessons learned and recommendations	Participants were generally happy with the program, despite it not growing as expected at many stations. The partnership was a model that could be replicated elsewhere.

The evaluation team interviewed members of the BART project team to better understand challenges, barriers, successes, and broader lessons learned from the implementation of the project. Section 5 reflects a synthesis of those interviews and the findings related to Hypothesis 13.

SECTION

5

Lessons Learned from Program Partners

The evaluation team interviewed members of the BART project team to better understand challenges, barriers, successes, and broader lessons learned from the implementation of the project.

MTC Carpooling Background

The Metropolitan Transportation Commission (MTC) has long managed the regional carpooling program. The U.S. Census Bureau's American Community Survey (ACS) has shown that since 2006 carpooling has been steady at about 10% of the region's commute mode share. Although carpooling participation has stagnated, Bay Area freeway congestion and public transit ridership are at near-historic highs. Given the constraints of both transit and highway infrastructures, MTC believes filling empty seats in cars is the quickest and most cost-effective way to provide more capacity. MTC also believes that the private sector can enhance ridematching by cultivating a larger match database (to establish a critical mass), integrating ridesharing with other relevant traveler services, and providing a user-friendly interface that removes the barriers associated with traditional carpool matching. To test this, MTC issued a call for partners among private-sector carpooling app providers. Subsequently, beginning in 2014, it executed zero-cost partnership agreements with four private-sector carpool matching app companies.

The partnerships required the apps to meet a set of criteria and agree to provide data to MTC. In return, MTC promoted the apps through its 511 Carpool Program. Note that when the Scoop to BART program started (and for most of the time when it was operational), MTC's carpool program was called the 511 Regional Carpool Program. This was recently rebranded to the Bay Area Carpool program. MTC had seven partnerships between 2014 and 2019. With the exception of Scoop and Waze Carpool, all others had left the market as of December 2017.

BART has had longstanding challenges with its legacy carpool program for which there is no clear solution. As these carpooling efforts were occurring at the regional level, it became clear that MTC's new partnerships could be a possible solution to BART's challenges. Parking at BART is very competitive, with all 47,000 parking spaces filling up early each weekday and with more than 35,000 people on monthly reserved permit parking waitlists. BART's carpool program, offered for 902 of BART's 47,000 spaces, is ineffective because SOV drivers, who are desperate to park at BART to avoid congested roads and high downtown parking fees, will violate carpool rules if no enforcement officers are present. Under the legacy program, BART carpoolers go to a website and print a permit for their dashboard alongside the permit of their carpool partner in the vehicle parked at the station. As long as there are two paper permits, carpoolers may park in a paid, first-come/first-served carpool parking space, typically located at a prime location near a station entrance. Additionally, because the carpooling spaces are provided on a first-come/first-served basis, there is no guarantee under the legacy system that users with a permit will find a space. The legacy program does not include marketing or customer service and does not assist users in finding carpool partners.

Around this time, BART was beginning to realize that the agency was at a crossroads and the agency could either add parking capacity or work to improve their "return on ridership" by trying to increase the average number of BART riders per parking space. BART ultimately concluded that the agency was not utilizing its parking assets as efficiently as possible and began to collaborate with MTC on potential programs to encourage meaningful behavior change through transportation demand management (TDM) strategies. Given Scoop's existing partnership with MTC and that the company had the largest market share at the time (which, in theory, should increase the likelihood of users finding a carpool match), project partners began to come together to consider additional ways for carpooling collaboration. BART began collaborating with Scoop and offering service at the system's Dublin Pleasanton station in January 2017. FTA's MOD Sandbox enabled BART and Scoop to add stations and expand the program.

As part of the MOD Sandbox, MTC partnered with BART and the carpool app Scoop to provide commuters who carpool to certain BART stations with reserved parking until 10:00 AM. The app matched two or more people into carpools, and Scoop provided data to BART parking enforcement to verify which vehicles belong to Scoop users. Scoop had methods to prevent people from cheating, but ultimately could not provide verification that the carpool (e.g., 2 or more occupants) actually took the trip. MTC's 511 Carpool Program proposed the pilot idea to BART and supported the program through customer and media outreach related to station launches. In doing so, this Sandbox initiative hoped to offer the following outcomes and impacts for key stakeholders:

- **Commuters**
  - Enhanced opportunities to carpool to BART stations
  - New environmentally-friendly option to access BART, particularly for riders with limited access to high-frequency fixed route feeder bus service
  - Assistance finding a carpool match and sharing the cost of a trip, including BART parking fees
  - Ability to arrive at a preferred time rather than before the time a station parking lot typically fills up
  - Priority access near station entrances

- **BART**
  - Better utilization of parking resources by increasing average vehicle occupancy at station parking facilities
  - Carpool verification that enhanced carpooling enforcement and reduced carpool cheating (e.g., SOV parking in a carpool parking space)
- **MTC**
  - Increasing capacity utilization of existing public transit infrastructure
  - Addressing core capacity constraints of San Francisco Bay Area public transit infrastructure
  - Improving air quality and emissions by reducing VMT and GHG emissions
  - Increasing utilization of HOV infrastructure
  - Strengthening relationships with public transit operators and carpool-matching app providers
- **Scoop**
  - Expanding geographic coverage of Scoop services to new areas and integrating features specific to public transit operators
  - Increasing the number of commuters familiar with carpool apps as a transportation option
  - Providing additional experience working with and addressing public agency needs

Challenges

In June 2018, the Scoop to BART program was active at 17 BART stations, and 300 people used the program on an average weekday. All stakeholders interviewed discussed numerous contractual challenges associated with this initiative, affecting the relationships between the project partners. These challenges can be summarized into five core issues:

- **Program Launch and Expansion** – All partners acknowledged BART for doing a great job organizing and managing the Sandbox project, including developing a launch plan, launching stations, and signing people up. Program partners did acknowledge, however, that, at times, there may have been a mismatch in project cadence between partners, where one partner was ready and another was not (and vice versa) throughout various stages of the pilot. As such, not all partners were always on the same timeline.
- **ADA Accessibility** – Under the original agreement, the vendor was supposed to incorporate ADA accessibility into its app, allowing a person with a wheelchair or mobility device to request a ride that could accommodate this equipment. However, in practice, this requirement was uniquely challenging because there may not be a critical mass of drivers with vehicles capable of accommodating this request since features that serve to

further segment the pool of carpoolers essentially raise the critical mass needed for high carpool-match rates, making it more difficult to match people. It was noted, however, that many mobile wheelchair users do not need a wheelchair-accessible vehicle; they can be matched into a regular carpool as long as there is space in the vehicle for their chair. No data were available on how often this was occurring. Scoop considered implementing a feature in the long term whereby people could state specific preferences or requirements such as a vehicle with a wheelchair ramp/lift, space for a wheelchair in the trunk, the need to bring a service animal, chemical sensitivities, or even non-disability-related preferences such as music choice, etc. In the end, the vendor could not incorporate ADA accessibility into the app within the scope of this project and, instead, provided contact information for people to call if they required special assistance. As of the date of the interviews, no one had called requesting accommodation.

- **Public Agency Concern about Contract Compliance** – BART noted that it was difficult to validate and audit the software engineering portion of the vendor's invoice due to the proprietary nature of the app's algorithm, making contract compliance difficult. Additionally, the vendor did not incorporate parking payment or ADA functionality into the app, which were two key contractual requirements. The vendor did acknowledge that these features would have required notable software engineering resources, that their company's business model evolved through the course of the pilot, and that they may have inadvertently under-resourced. The vendor urges other startups to exercise more due diligence prior to signing MOD Sandbox contracts. Project partners urge clear contract requirements and payment milestones to avoid scope creep (actual or perceived) and ensure that all agreed-upon contractual terms are completed. Finally, carpool verification and enforcement were another contractual pain point for the partners due to unclear contractual expectations and the time-intensive nature of verification through data analysis.
- **Issues Related to Carpool Verification and Enforcement** – A number of issues were identified specific to verifying carpools and enforcement action for SOVs parking in carpool spaces, including defining a valid carpool and perceived carpool violations, carpool verification, and the desire for more detailed data to verify carpools.
  - *Defining a Valid Carpool and Perceived Violations* – From the perspectives of Scoop and MTC, a valid carpool is any two or more people sharing a ride for any part of a journey or to a final destination. With the implementation of the Sandbox project, this included two people traveling in the vicinity of a BART station, even if only one person was a BART rider. These types of trips tended to occur when two carpoolers were matched when the driver was going to park at BART and a rider was simply going to transit-oriented destination in the immediate station vicinity. From an enforcement perspective, these types of trips created the illusion of carpooling parking

fraud to parking staff and BART police because a driver could drop off their rider at the front door of their destination, then park and exit the vehicle with just one passenger (giving the illusion of an SOV parking in a carpooling space). Enforcement officers were used to enforcing the legacy carpool program by observing whether one person exited the vehicle; thus, it took time to get used to the idea that the Scoop to BART program permitted carpooling with users not going to BART. Although valid related to program design, BART hoped to increase ridership by having at least two BART riders per carpooling vehicle. For enforcement, it would have been useful to have real-time information on the number of people arriving in and parking a vehicle at BART so enforcement officers could refer to the license plate list and enforce the parking spaces accordingly. This was added in the contract addendum, but these kinds of data were not available for most of the program.

  – *More Detailed Data to Verify Carpools* – In general, Scoop found it difficult and time- intensive to validate numerous data requests specific to verifying carpools and enforcement. Additionally, BART wanted more detailed data to verify trips, and Scoop had a policy of not tracking trips to protect user privacy and due to technical challenges (e.g., app has to be open or running in the background and there is no user incentive to keep the app running after a match has occurred and the journey is underway).

- **Unique Public Sector Requirements** – BART had many unique requirements (e.g., ADA accessibility, data reporting, etc.) due to its own processes as well as part of its Federal funding documentation requirements. Responsibilities among public and private partners should be clearly defined to ensure commitment among all partners and stakeholders.

Lessons Learned

A number of the program challenges existed because BART maintained two carpooling programs simultaneously, which created confusion among some carpoolers. Although the Scoop to BART program was ongoing, BART made the decision to retain the legacy carpool parking program. In doing so, users had two distinctly different carpooling options:

- **MOD Sandbox Pilot** – Use the Scoop app and pay for parking but receive a guaranteed parking space. However, users never paid for parking since the agreement was that Scoop would pay for parking until they added parking payment as a feature to their app, which did not happen.
- **Legacy Carpool Program** – Print paper permits and carpool to BART with paid but not guaranteed parking. The legacy carpool program also requires people to find a carpool partner on their own, which can be someone they already know.

BART hoped to conclude the legacy carpool program but wanted to test the app-based carpooling program first before discontinuing the existing program. The result was that sometimes Scoop users would park in carpool parking spaces dedicated for paper permits and get cited because they did not have a paper permit. This caused some carpooler confusion in which Scoop had to verify the carpools so BART could reverse the tickets. In the end, BART decided to replace both programs with a carpool program on BART's smart phone application. The transition is still in progress, and BART hopes to end the legacy carpool program in early 2020.

The Scoop to BART program was a learning experience for all stakeholders about who is carpooling, how they carpool, and the types of enforcement and verification issues that can arise from this type of pilot design. For example, the partners learned that they had different definitions of qualifying carpools, including 1) two BART riders carpooling to BART and entering the station at the same time; 2) two BART riders carpooling to BART, but entering the station at different times (e.g., a person dropping off their carpool partner at the station entrance); and 3) two people carpooling to BART (one BART rider and another accessing transit-oriented development). It is worth noting, however, that expanding the program to include matches at adjacent transit-oriented destinations improved matched rates, almost certainly expanded potential carpool matches, and allowed BART users to match as a rider in a carpool with the driver not parking at BART. This pilot highlights the need to clearly define eligible carpools and to share this definition with enforcement authorities (e.g., BART police, parking attendants, etc.). In the end, interviewees reported that Scoop to BART was a much more effective program combating carpool cheating than the legacy carpool permit program. The ability of BART to improve carpooling parking enforcement through an app-based program represents an important milestone for the agency because of a long-term trend of reduced parking availability due to joint development at stations. As such, increased parking occupancies represents a core strategy for the agency to manage parking in an efficient way.

Although well-intentioned, BART's ADA component of the Scoop to BART project likely would not have been effective had it been implemented as originally envisioned. Although all partners wanted an equivalent level of service for people with disabilities, the smart phone app had limitations in bridging this gap, and there were system limitations that were challenging to overcome in the pilot. As noted earlier, obtaining a critical mass was essential to gaining successful traction in carpooling, and there may not have been a critical mass of drivers with vehicles capable of accommodating ADA requests since features that further segment the pool of carpoolers result in lower potential matches. However, it was noted that not all persons with disabilities required specialized vehicles. It was also possible that the program did not emphasize accommodations for persons with disabilities; hence, its use was not attempted. Accessibility also extends beyond physical accessibility, and providing an accessible app for multiple languages and auditory and visual disabilities is also critical to such service. Scoop considered implementing a feature in the long term whereby people could request specific accommodations such as a vehicle with a wheelchair ramp/lift, space for a collapsible wheelchair, the need to bring a service animal, etc.

In general, the partners acknowledged that BART was able to obtain relatively robust data compared to other public agencies in the MOD Sandbox. Broadly, BART reported that Scoop was a good partner in providing data for an array of agency metrics and enforcement data (e.g., number of user warnings to support enforcement). During the course of the pilot, BART received a public records request from a law firm requesting potentially sensitive proprietary information, such as number of people, carpooling routes, and match rates. Although information shared with BART did not raise concerns about user privacy, and BART is not required to provide sensitive user information in public records requests, this experience raised awareness about data sharing with public agencies (particularly for a startup company).

There exists an ongoing perception that carpool-matching apps are not financially self-sustaining and may become defunct or change their business model. Although BART initially renewed the contract for an interim period, the agency went through a period of self-reflection that resulted in it deciding to add carpool functionality to its app rather than depending on a third party for matching. Some factors that entered into this decision included Scoop's change in its business model, its unwillingness to enter into a long-term contract (e.g., 10 years), its reticence to provide positive verification of carpools to address fraudulent use or streamline enforcement processes (a significant issue for BART), and the decision to charge for a service (above the cost of parking). In particular, Scoop's monetary request would have required BART to go through an open procurement process, as other carpool-matching and verification options had since entered the market. Scoop's desire for short-term contracts would have resulted in relatively frequent and time-consuming procurement processes as well as considerable financial risk to BART, because costs could have continued to increase at each contract expiration and result in contractual instability that ultimately could have forced users to repeatedly change carpool apps.

BART also desired to consolidate carpool programs while also providing carpooling incentives to users who would have not been able to use Scoop, such as persons with known carpool partners, non-peak period/weekend trips, trips that begin outside of Scoop's service area, or accounting for at least one carpooler that does not have access to a smart phone. Unrelated to Scoop, strategic long-term changes in BART's parking management and enforcement processes and the new availability of tools such as BART's own app, which included account and payment features, made bringing carpool payment/verification in-house an option that previously would not have been possible.

Collectively, these issues caused BART to realize that the agency could not continue to rely on the private sector to provide these services on a continuing basis and that BART riders could be left without a consistent carpooling program in the future. Along with the desire to retain control over data and rationalizing the various parking permit and payment options at BART, BART began the process to include carpooling in its app that would replace both Scoop and the legacy carpooling program. As the BART app was being developed, it was not initially planned for carpooling until the agency was forced to develop another option. Functionality on BART's smart phone application is being released in phases, and carpooling functionality was rolled out in June 2019 at the top four Scoop carpooling stations (Antioch, Orinda, Warm Springs, Dublin/Pleasanton). The design of carpool payment/verification function in the BART app took into consideration many lessons learned, both success and challenges, from the Scoop to BART pilot program. The pilot enabled the inclusion of a carpool parking and verification feature in BART's app by raising the visibility of carpooling. This made it a key strategy for improving the efficiency of dwindling parking resources and advancing parking management practices at BART. The investment required to include this feature into BART's app was significant and would likely not have been made had the Scoop to Bart pilot not created the precedent for an improved and successful carpool program.

In summary, stakeholder/project partner interviewees reported that through the survey responses, it was clear that participants were generally happy with the program, despite it not growing as expected at many stations. Interviewees concluded that it may be difficult to encourage carpooling at stations that are not at the end of the line, potentially due to challenges of promoting carpooling for distances less than 10 miles. Although the Scoop to BART program eventually ended, all project partners agreed that the partnership was a model that could be replicated elsewhere and offered a blueprint for how to deploy a similar program.

SECTION

6

Conclusions

The evaluation determined that the Scoop project achieved a number of its objectives in the form of the proposed hypotheses, as indicated below.

Scoop enabled a considerable increase in carpooling to BART stations, as demonstrated through the analysis of Scoop activity data from July 2017 to April 2019. The vast majority of this activity was at the Dublin/Pleasanton BART station, which, by itself, was the origin or destination for 70% of all carpool person-trips. However, other termini of the BART system, including the Warm Springs station in Fremont and the Antioch station in Antioch, were also recipients of significant Scoop carpooling activity.

Utilization of parking spaces by carpooling vehicles also increased. Scoop activity data allowed the calculation of the number of vehicles parked at BART and their occupancies and showed that a number of scenarios were possible. Scoop vehicles could carry up to three people in a carpool, enabling up to six carpool trips per parked vehicle for a single day of travel. However, Scoop carpool vehicles could also drop off a carpooler before reaching BART and then park at the station, yielding only one BART carpooler trip per parked vehicle. The analysis found that system-wide, Scoop delivered 2.41 carpooling passenger trips for every vehicle parked.

The evaluation explored the cost of enforcement per carpool space given the ability of Scoop to provide more detailed information on who was carpooling on a given day. This had to be more qualitatively assessed, as the marginal differences of enforcement activity that resulted strictly from Scoop were not quantitatively tracked over time. BART enforcement felt that the additional marginal Scoop-specific enforcement activity added about one hour per week of labor. Relative to the broader enforcement activity, this was calculated to be an increase of about 0.3% of additional labor costs resulting from Scoop-specific enforcement, a cost that mainly involved checking the list of license plates registered as carpools. The permit lots in which Scoop vehicles were parked were patrolled regularly, and the cost of these patrols was not specific to the Scoop program.

Citation data were provided to the IE to evaluate whether instances of illegal carpooling declined as a result of the Scoop program; however, the data available were not sufficiently detailed to quantitatively determine whether instances of illegal carpool parking declined per total carpool spaces available. Although a quantitative conclusion was not possible, qualitative discussions with BART enforcement staff noted that rates of fraudulent use with Scoop were very likely to be lower than with the legacy carpool parking spaces, simply because identifying a fraudulent carpool with Scoop was considerably easier. Fraudulent use of the legacy carpool parking spaces had to be identified as the person was leaving the car without another passenger, whereas permit violations with Scoop could be determined, at least in part, through a review of a list of license plates assigned to carpools going to BART.

Scoop enabled carpoolers to spread out their trip start times over the course of the project. The analysis of BART station arrival times, as originally planned, was not possible, but data permitted a congruent analysis of carpool trip start times. The analysis found that although average start time shifted from 7:30 AM to 7:00 AM over the course of the project, the spread of start times increased across the hours of 6:00 AM to 10:00 AM.

Scoop increased the number of persons per parked vehicle at participating BART stations. This result could not be computed directly since the overall occupancy of other vehicles using the lot was unknown. However, with some assumptions, it was estimated that by the end of the project that Scoop may have increased the persons per parked vehicle by upwards of 5% for the Dublin/Pleasanton station and by upwards of 1% at some of the more active stations with lower volume. These estimates comprised an upper bound of likely impacts, but the overall conclusion is that Scoop increased the number of persons per parked vehicle at the BART station parking lots.

A considerable share of Scoop users would have driven alone or traveled in an SOV (including TNCs) had Scoop not been available. When asked how they would have traveled for their most recent trip in the absence of Scoop, 41% of respondents reported that they would have driven alone to or from BART, 14% reported that they would have taken Uber or Lyft, and 9% reported that someone would have had to drop them off or picked them up at the BART station. All alternatives would have increased VMT relative to carpooling. Others reported shifts from public transit (11%), walking or bicycling (4% together), and not taking the trip at all (8%). These responses were combined with the Scoop activity data to evaluate the change in VMT that likely resulted from Scoop. Assumptions had to be applied regarding mode shift across the activity data and what the combination of mode shifts with carpool vehicles implied regarding VMT changes. For example, two Scoop riders previously using the bus as an alternative to carpooling with Scoop would result in an increase in VMT. In contrast, two Scoop riders previously driving alone as an alternative to carpooling with Scoop would result in a decrease in VMT. The analysis found that Scoop very likely results in some notable declines in the VMT traveling to or from BART.

Scoop users reported increased frequency of use of BART as a result of Scoop. An analysis of ridership data was not able to empirically isolate coefficients attributing changes in ridership to Scoop. BART ridership, and the fluctuations that come with it, were found to be too large relative to the size of Scoop activity to identify impacts using econometrics or statistical tests. Similar conclusions were found for evaluations of impacts on revenue.

A large minority (40%) of Scoop users reported reduced cost relative to their primary alternative as a reason for traveling with Scoop. From the driver perspective, 30% of users also considered cost recovery as a key reason for using Scoop. Others considered the ability to access station parking, which was highly-constrained across the system, as a key reason for using Scoop (58%). Other commonly-cited reasons included flexibility in arrival times, offering an alternative to driving, traveling faster, and improved safety of travel as reasons for using Scoop.

The Scoop project offered lessons learned to build on future projects. Expert interviews with those close to project implementation revealed several findings related to contractual negotiations, project operation and expansion, accessibility challenges, and other issues related to the continuation of the project. The interviews found that stakeholders/project partners were generally satisfied with the project, even though it did not grow as expected at many stations. As found in the data analysis, project stakeholders/partners noted difficulties with encouraging carpooling to stations that are not at the end of the line.

The overall experience with the Scoop project raised some policy issues that could be worth closer inspection in an effort to advance carpooling and other innovations in public transit. Perhaps central to the carpooling project are the policies that govern what can be legally given as monetary incentives to those carpooling. This stems from the regulation of income, classification of services, cost reimbursement, and benefits. To incentivize carpooling, Scoop compensated drivers at an amount up to the IRS per-mile reimbursement. There were also other incentives that could be given to drivers and riders, depending on demand, which participating agencies would financially support and Scoop would transmit to drivers or riders. This broader approach to encouragement of carpooling with incentives raised issues regarding regulations that could apply to compensating drivers providing carpooling. The capability of BART to incentivize drivers was generally restricted to lowering the cost of BART-provided goods, namely parking (i.e., providing an in-kind, non-monetary incentive of a guaranteed parking space). But can policies provide direct monetary incentives beyond cost-reimbursement? Most transportation policies seek to encourage behavioral change through the elimination of cost, be it monetary or time-based. However, for some of the desired behavioral changes, the reduction of cost may not be enough to entice significant shifts in behavior. This could call for some middle-ground definition of a carpooling driver who is compensated within the bounds of Federal cost reimbursement and a TNC driver with no upper bound on compensation but with taxable income.

Flexibility in the financial mechanisms that can be used for incentivizing carpooling could be warranted. Such barriers were not considered in this project, but they could arise in future projects. Within certain environments, the mitigation of costs may not be enough to gain the full potential of carpooling in a region. Regulations related to compensating transportation services could inhibit more ambitious efforts of this type; thus, there may be some benefit to defining some classification of a carpooling driver or rider who can receive greater compensation for the using the mode for commuting purposes.

These and other insights emerged from the Scoop to BART project. Although the program ultimately ended, it demonstrated a number of successes with respect to expanding carpooling as a form of access to transit. The lessons learned from the pilot project not only have helped BART to take the next steps in improving its carpool program but should allow for future projects to build on this experience and advance common objectives with similar initiatives within other transit systems.

APPENDIX

A

Additional Survey Results

The following plots show raw summaries of survey results. The figures are in the general order of questions asked. Only questions not presented previously in the report are presented in this appendix.

Figure A-1

Scoop use to or from BART

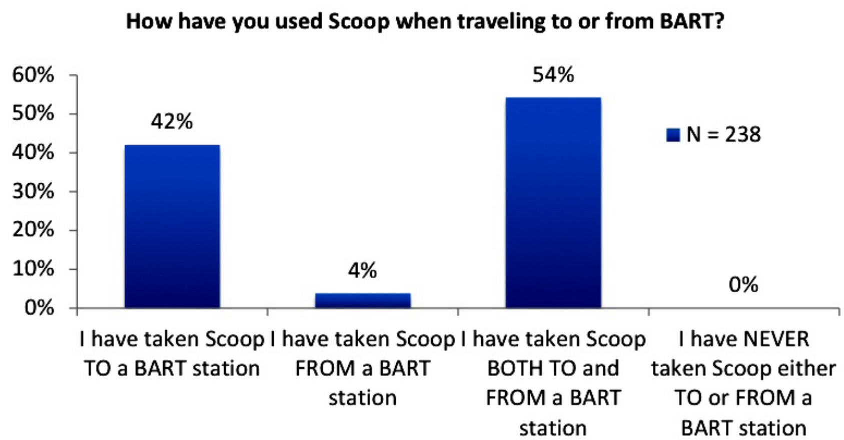


Figure A-2

Bus travel as a result of using Scoop

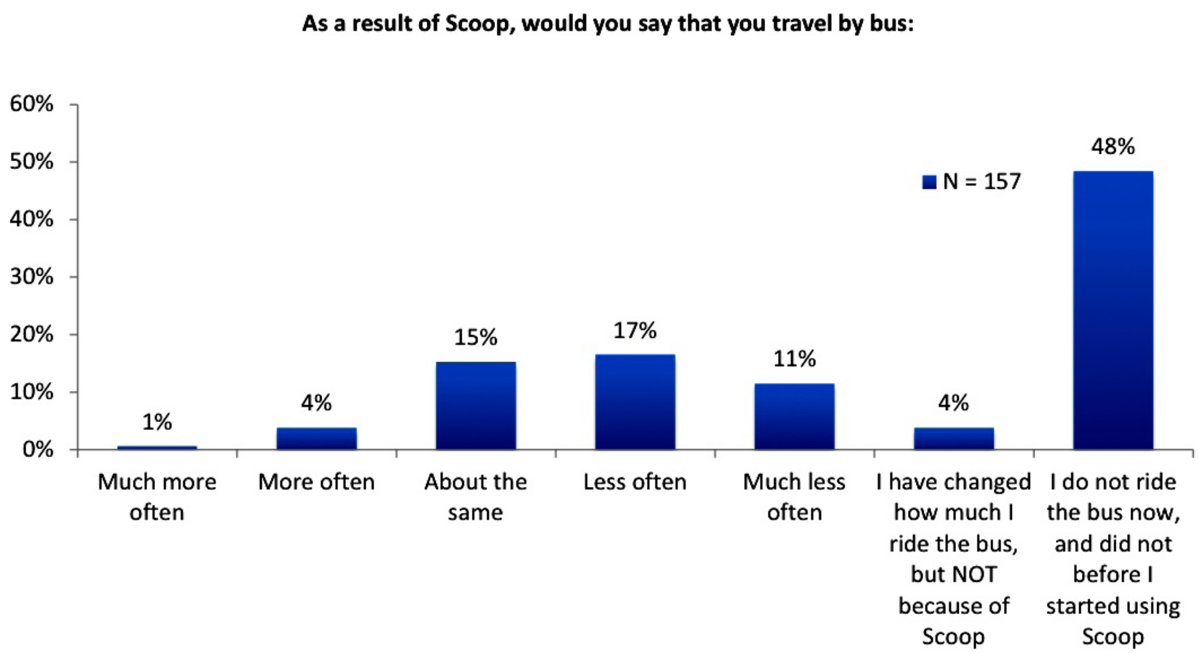


Figure A-3

Regular Scoop use to or from BART

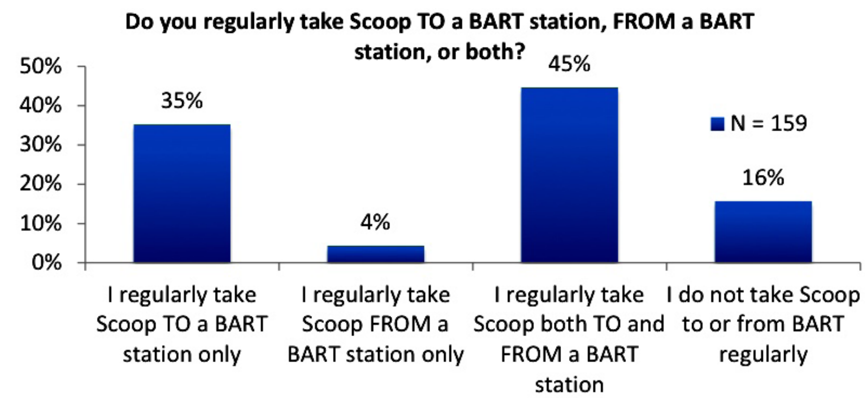


Figure A-4

Day of Scoop trip

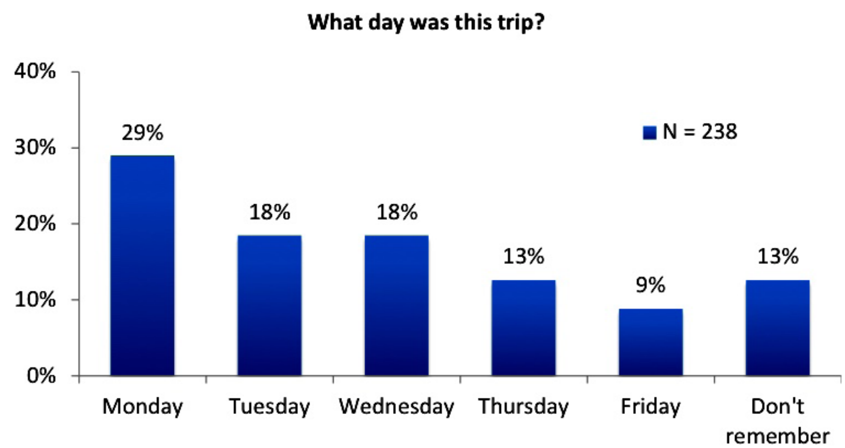


Figure A-5

Scoop alternative to get to/from BART

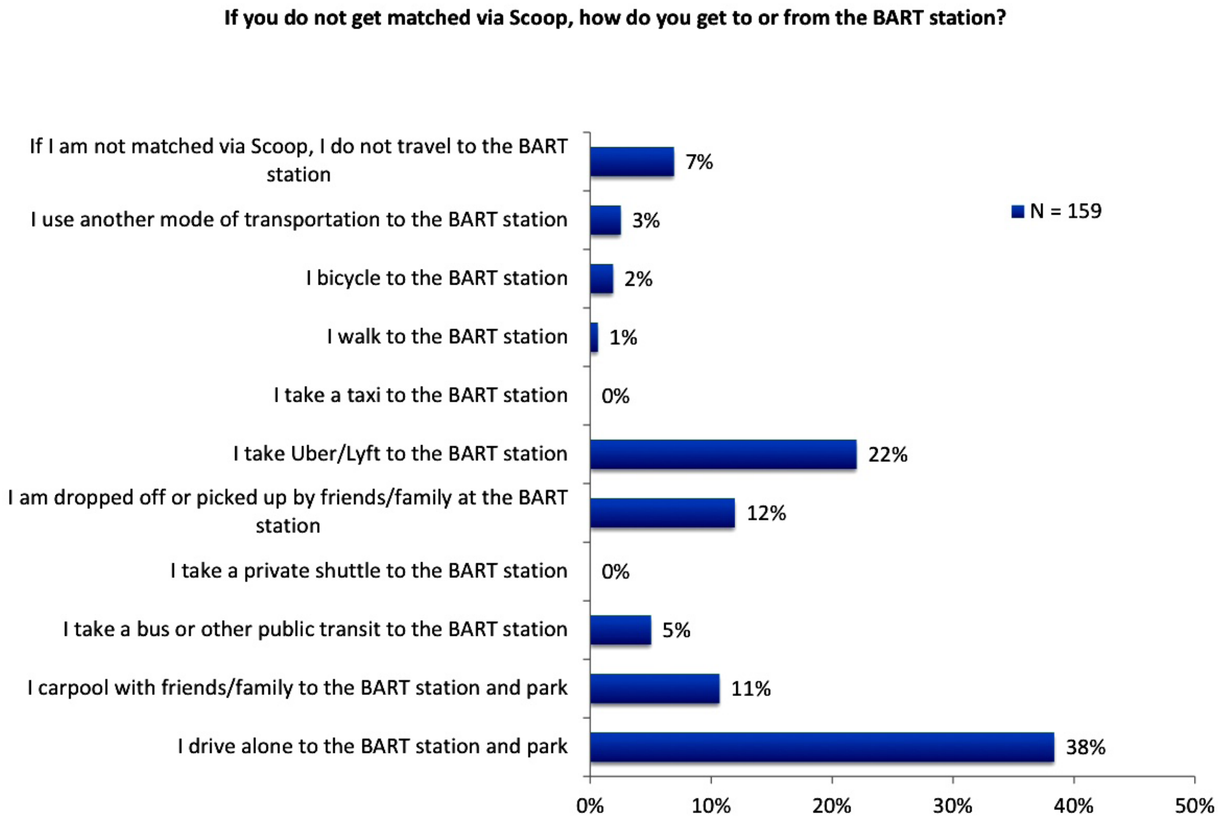


Figure A-6

Riders and drivers in Scoop trips

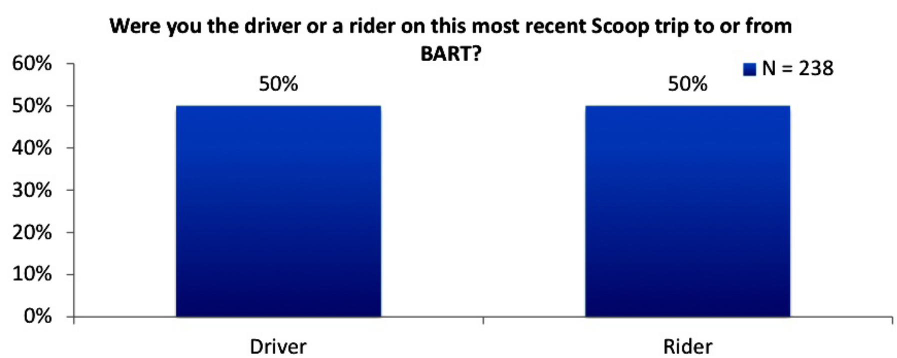


Figure A-7

Scoop trip purpose

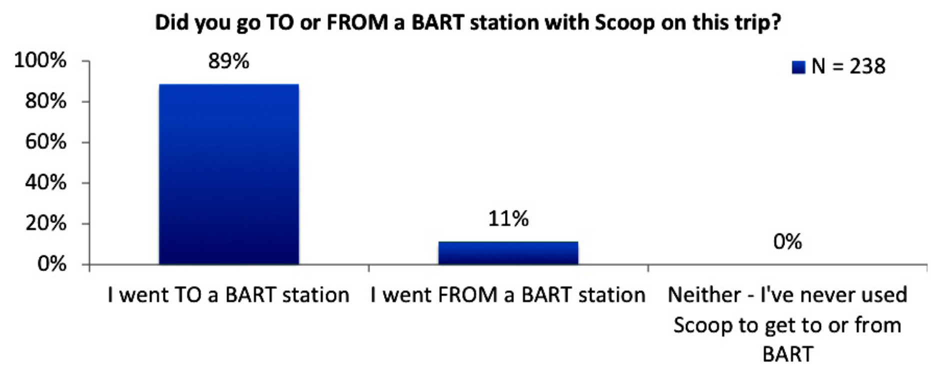


Figure A-8

Scoop trip BART station destination

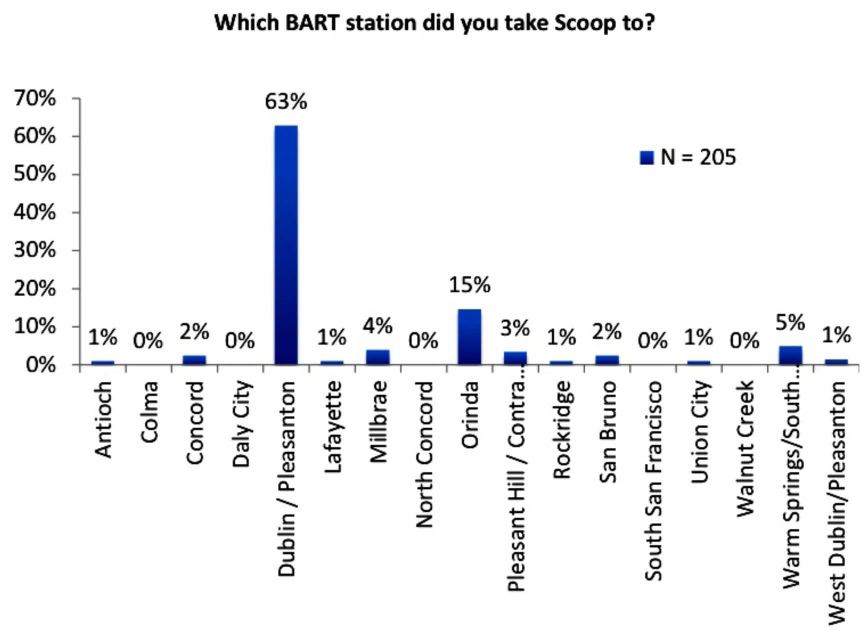


Figure A-9

Scoop trip origin

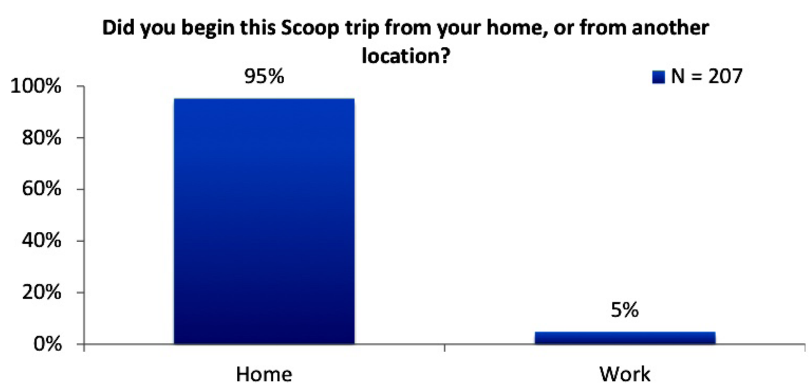


Figure A-10

BART trip purpose

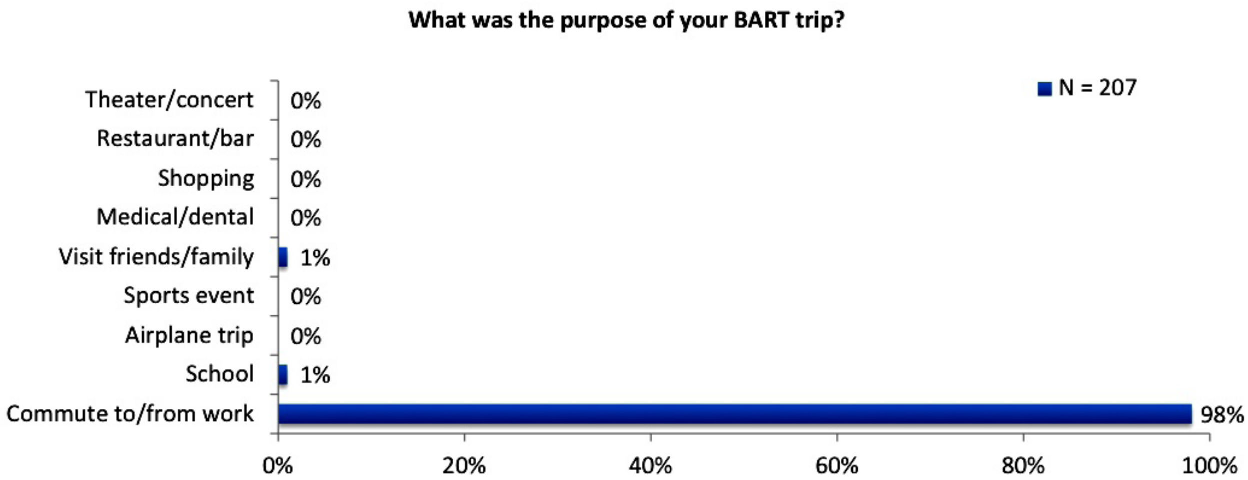


Figure A-11

BART trip station destination

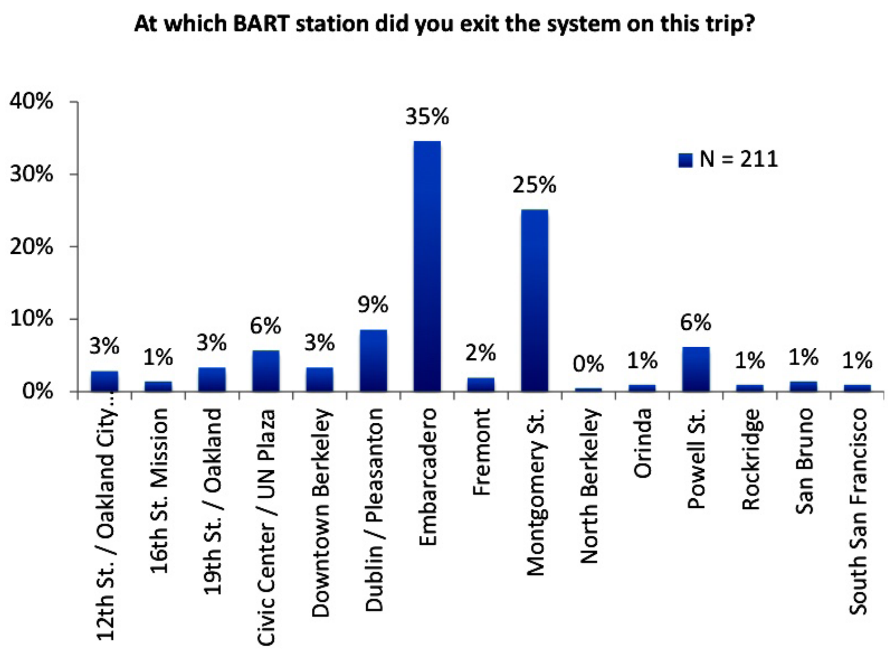


Figure A-12

Transportation mode to return from BART

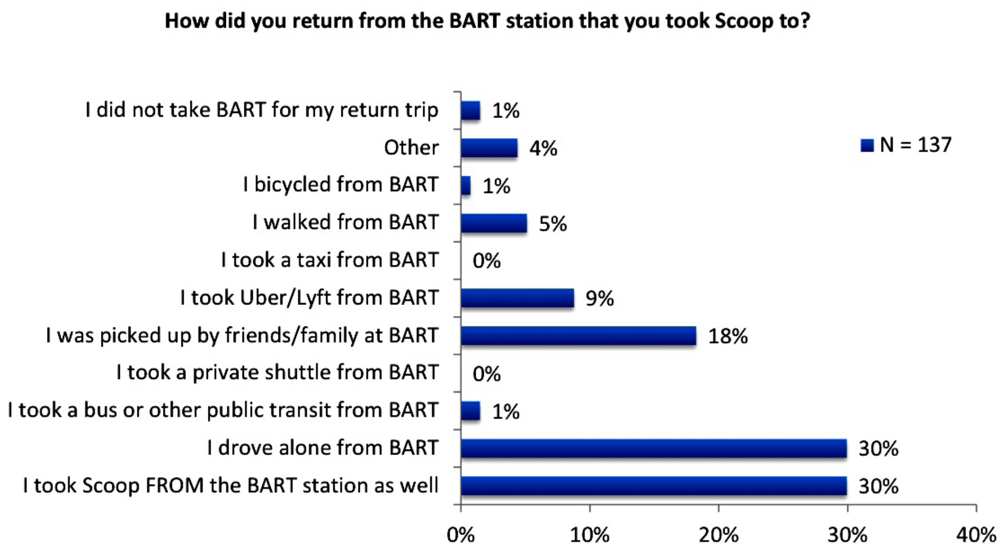


Figure A-13

BART station origin before Scoop trip started

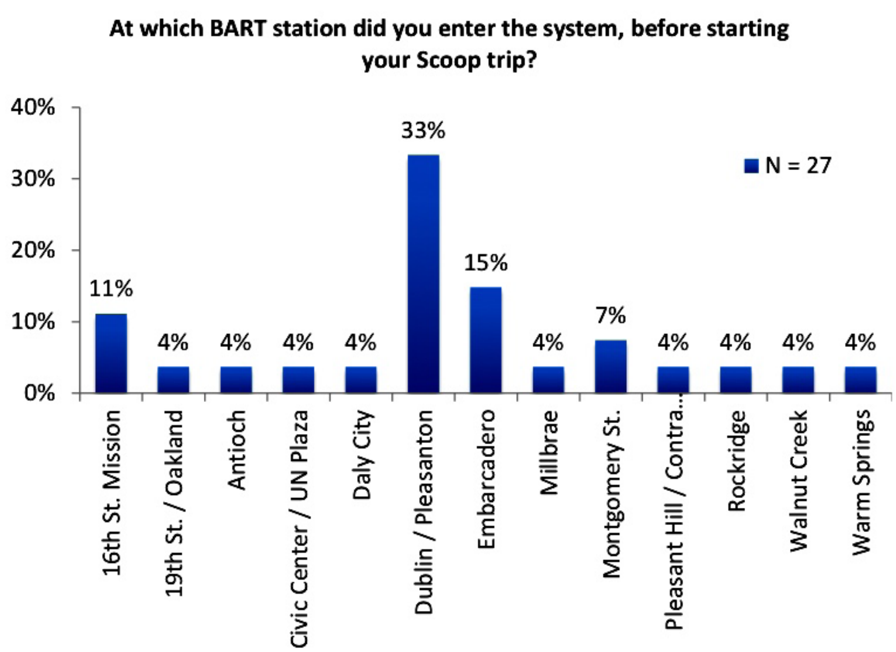


Figure A-14

BART trip purpose before Scoop trip started

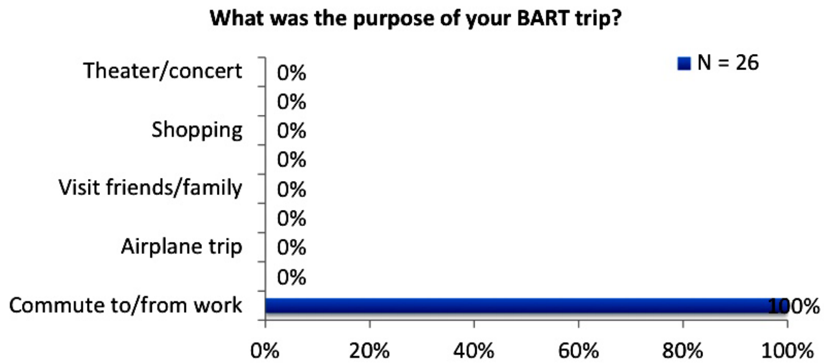


Figure A-15

BART station destination before Scoop trip started

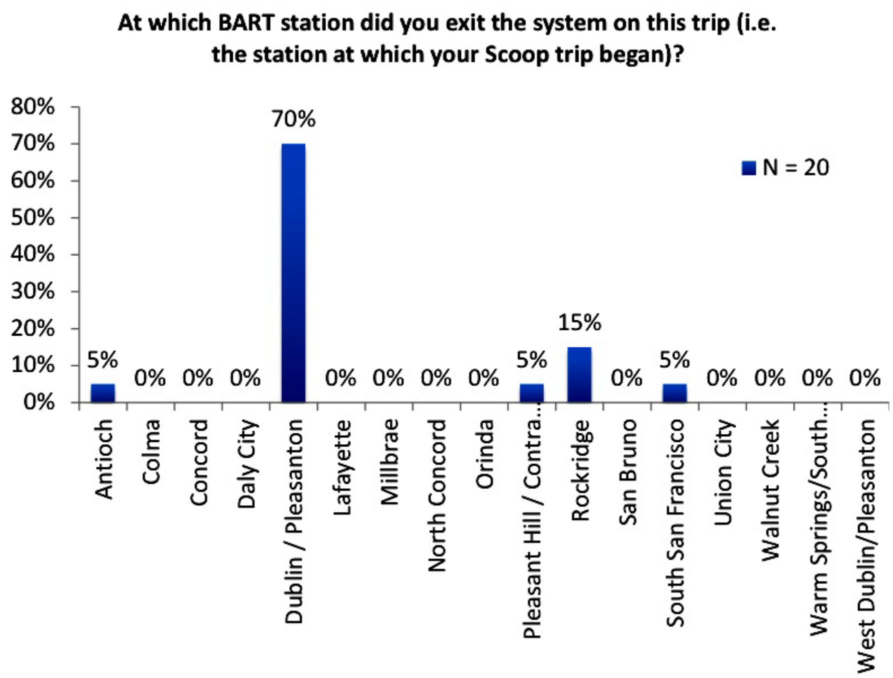


Figure A-16

Trip final destination

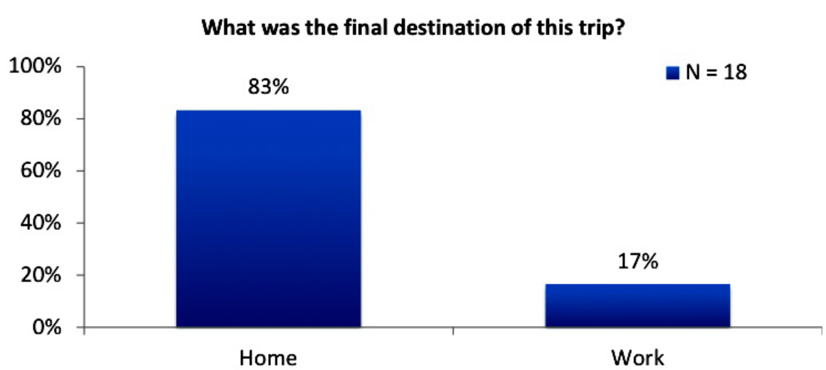


Figure A-17

Scoop alternative to reach final destination

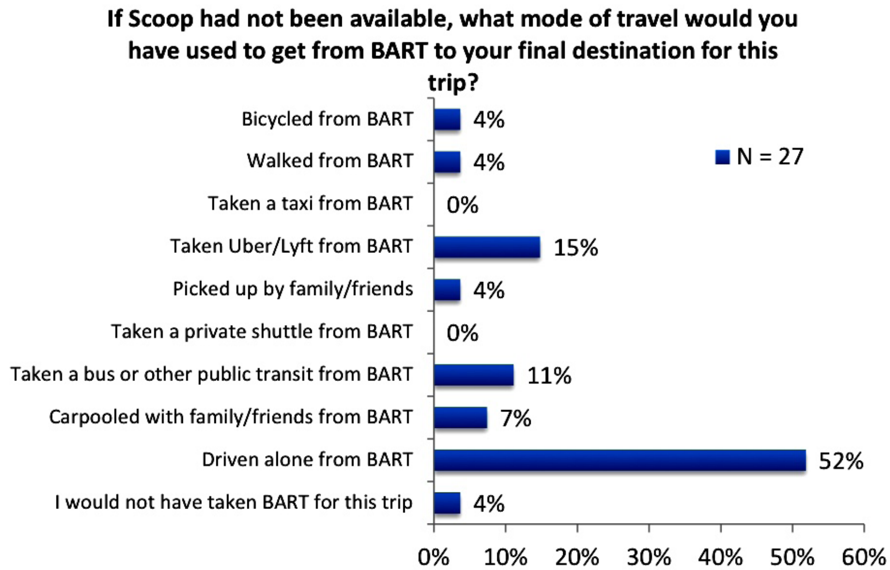


Figure A-18

Non-Scoop outbound/return mode

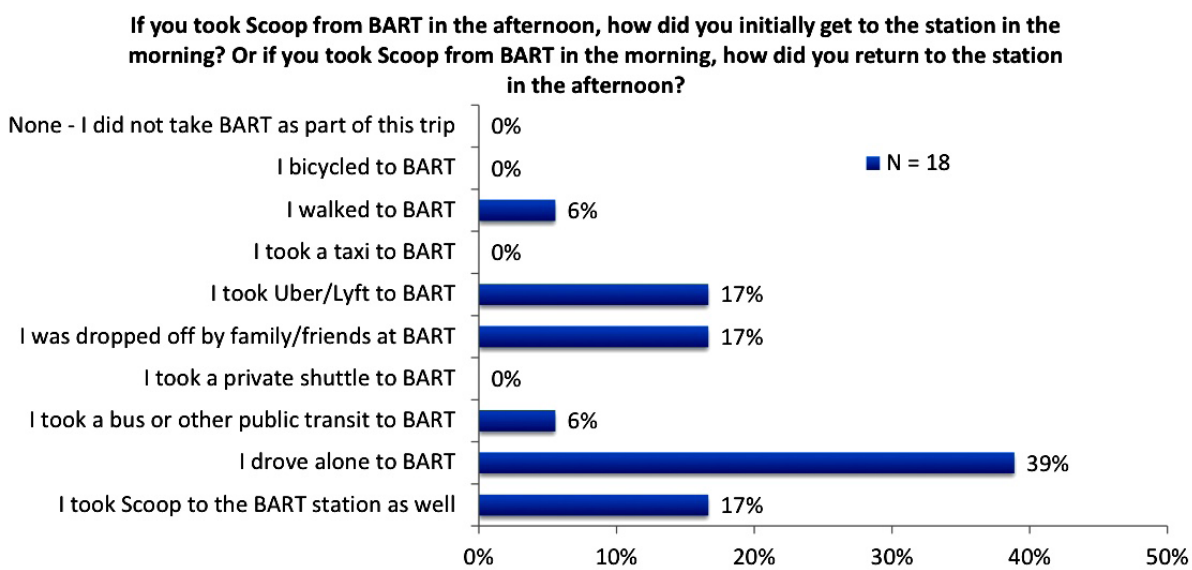


Figure A-19

BART alternative to reach final destination

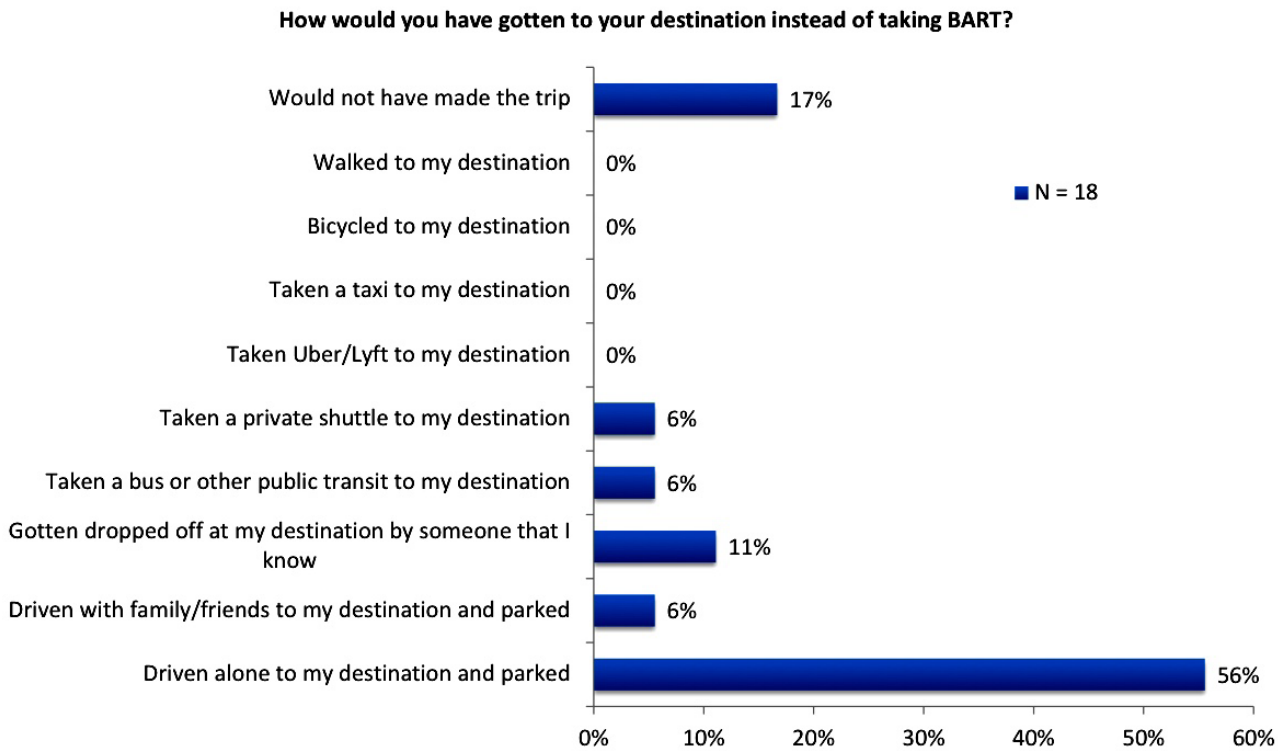


Figure A-20

Car ownership

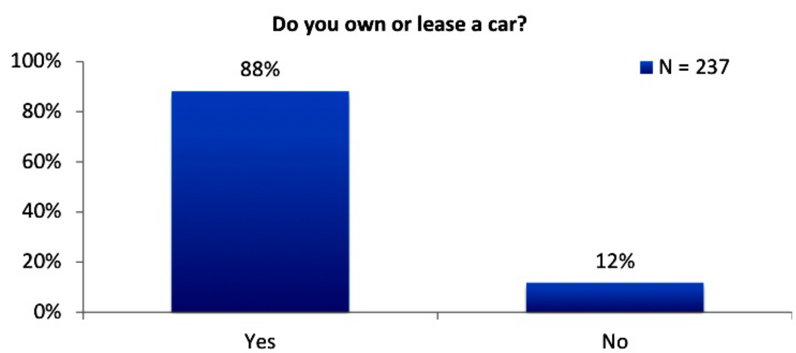


Figure A-21

Gender

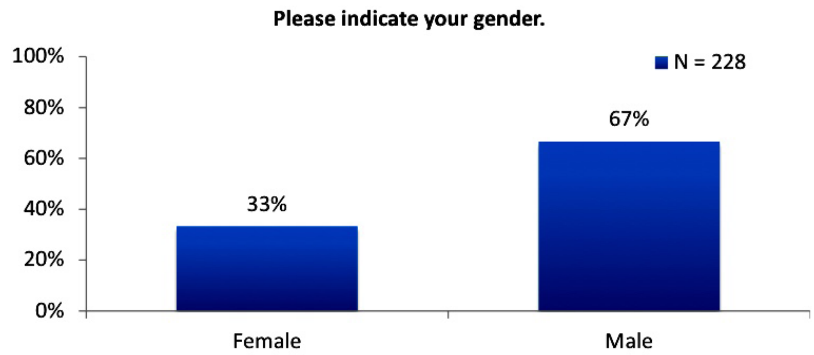


Figure A-22

Level of educationr

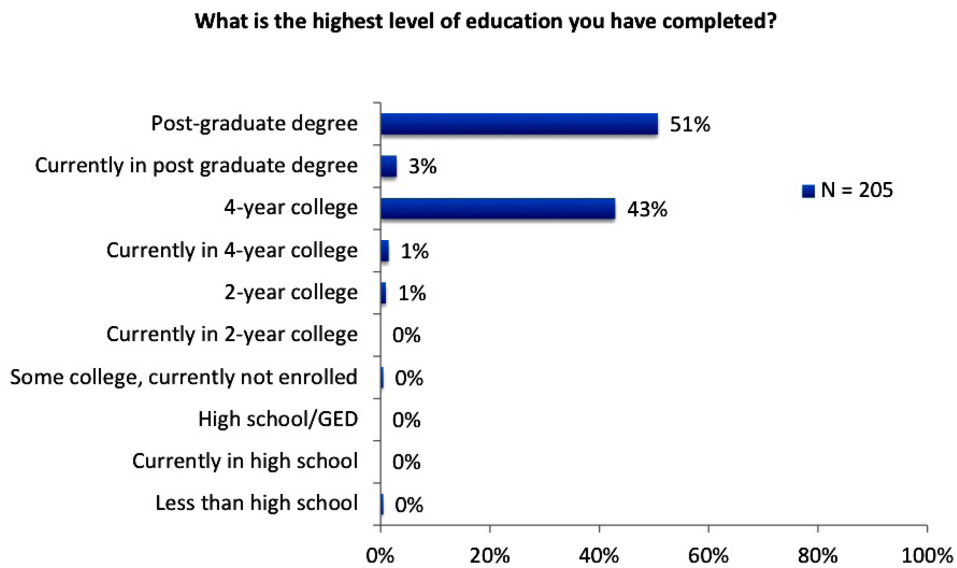


Figure A-23

Race or ethnic identification

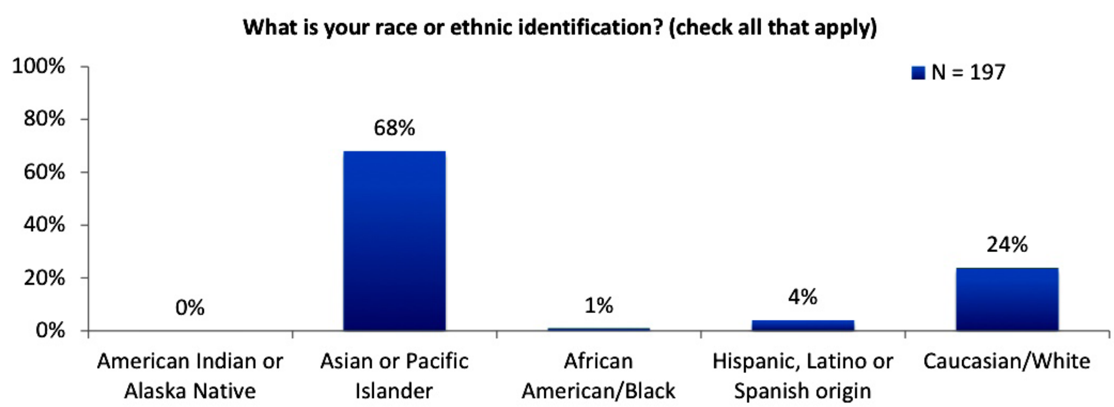


Figure A-24

Languages spoken

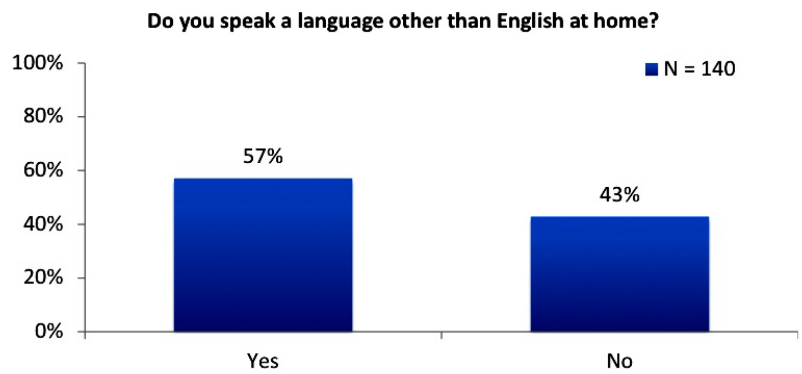


Figure A-25

Level of English proficiency

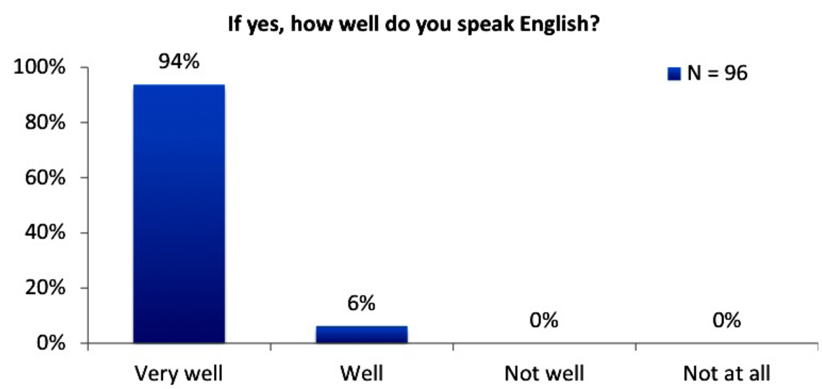


Figure A-26

Household level of income

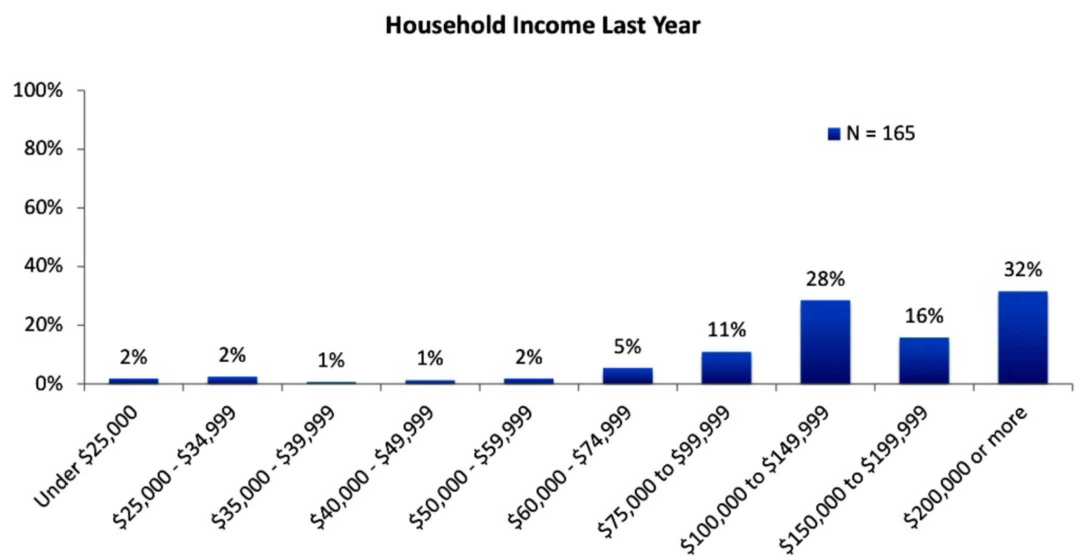


Figure A-27

Household size

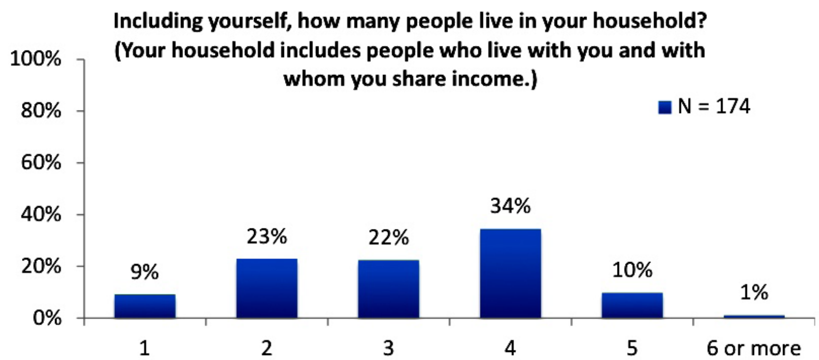
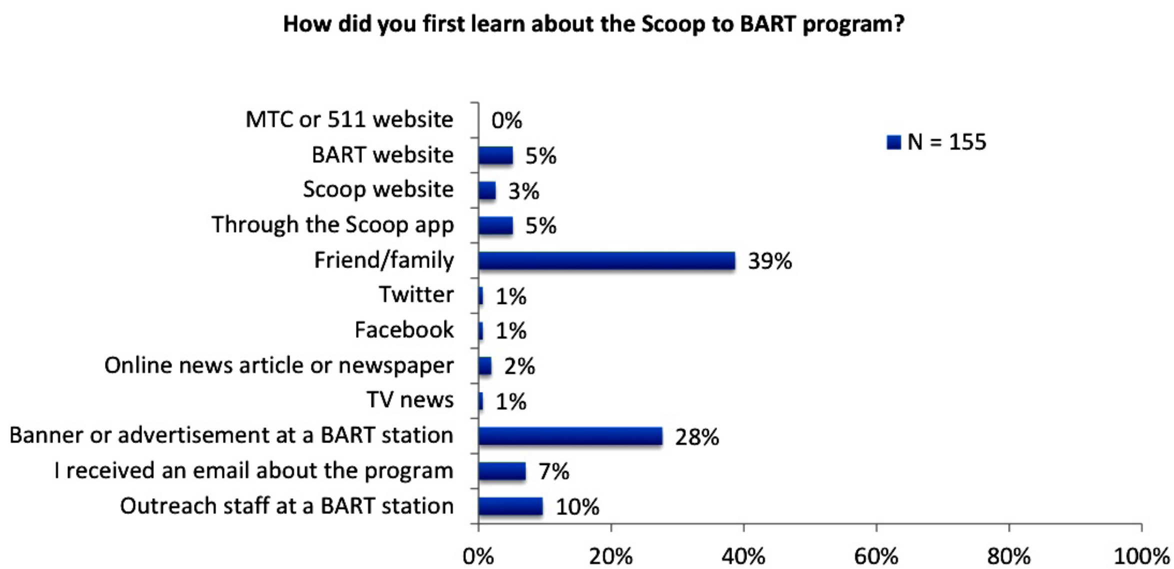


Figure A-28

Source of learning about Scoop to BART program



APPENDIX

B

Ridership Activity

Ridership Charts

The following charts show the variation in ridership for each of the 17 stations over the study period.

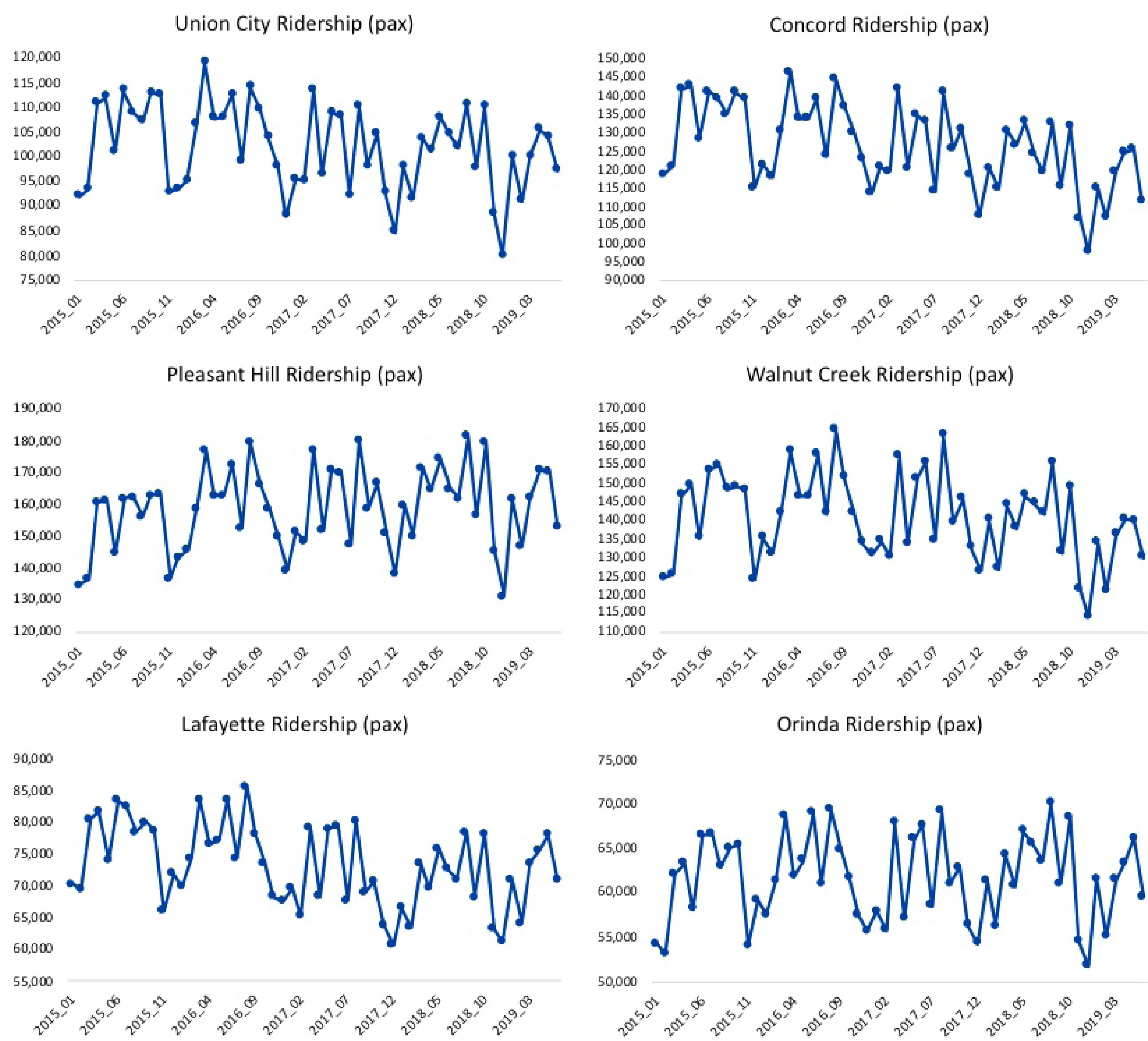


Figure B-1

Variation in BART ridership (1)

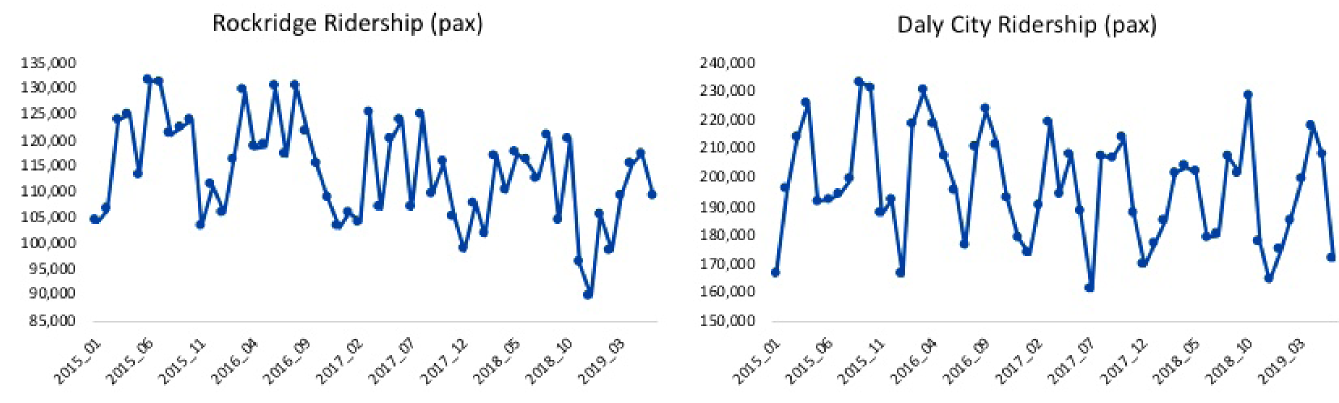


Figure B-1 (cont.)

Variation in BART ridership (1)

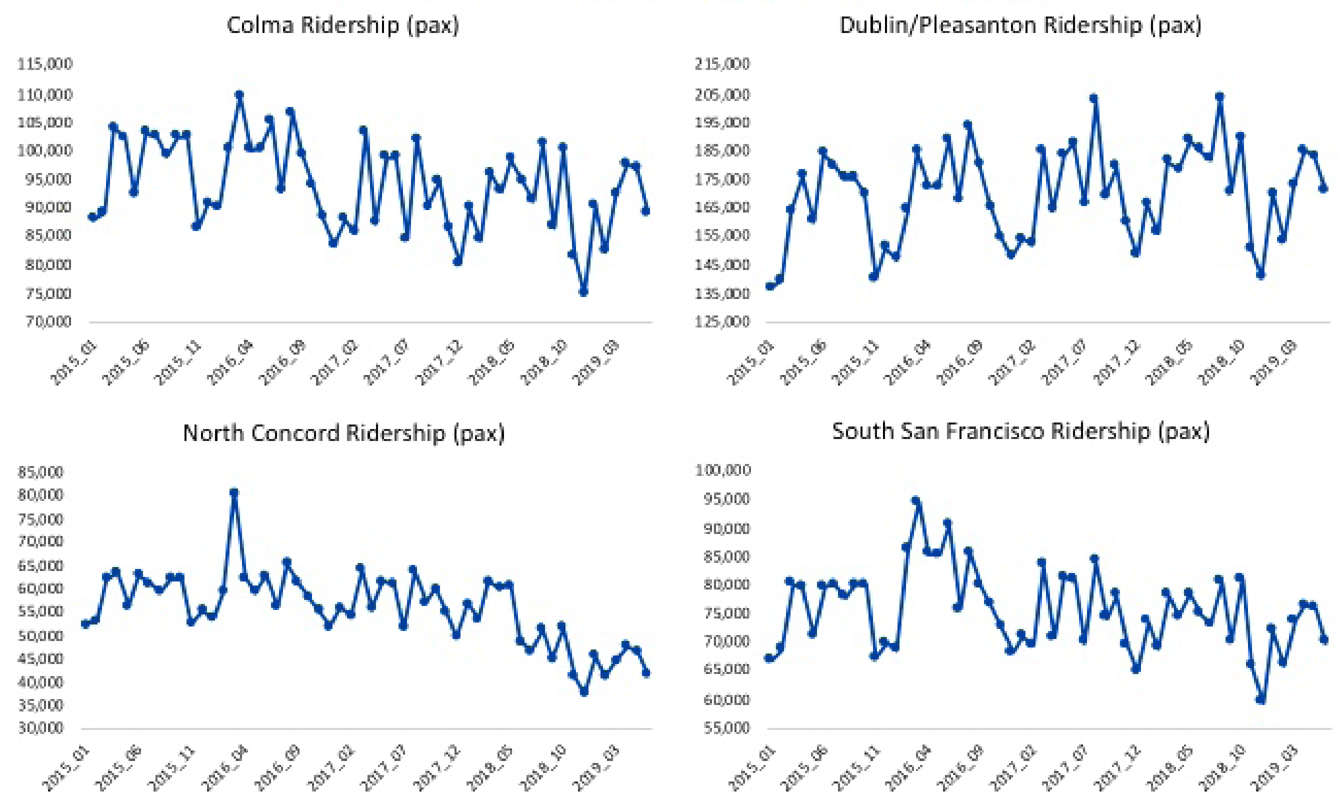
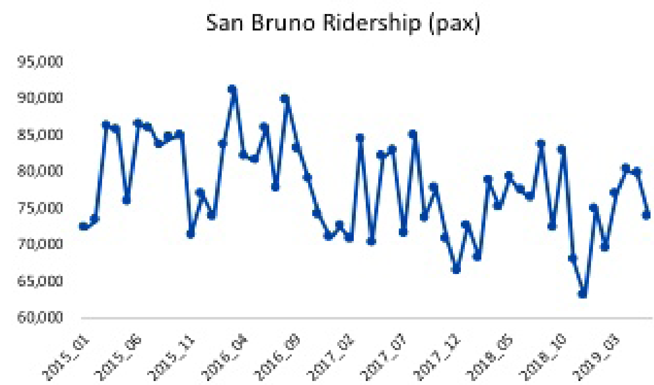
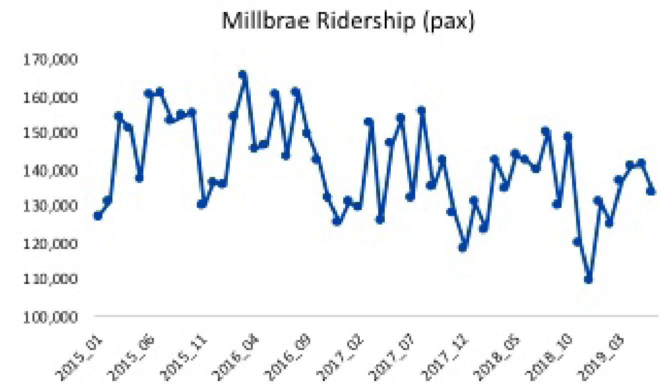
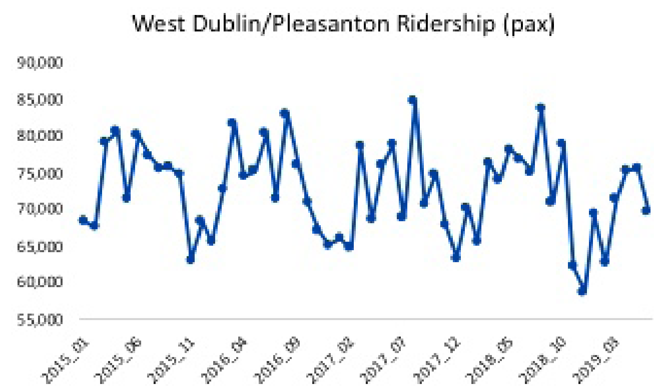


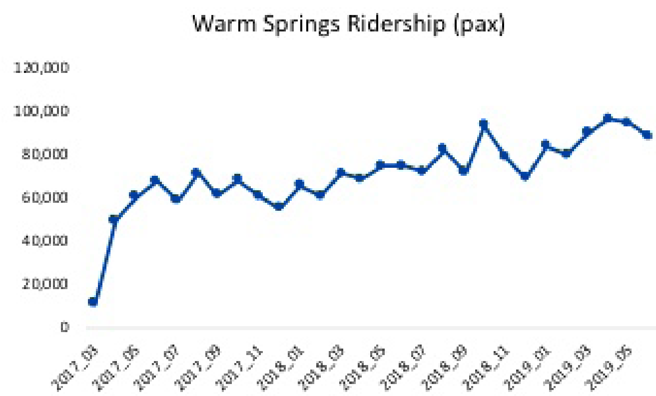
Figure B-2

Variation in BART ridership (2)









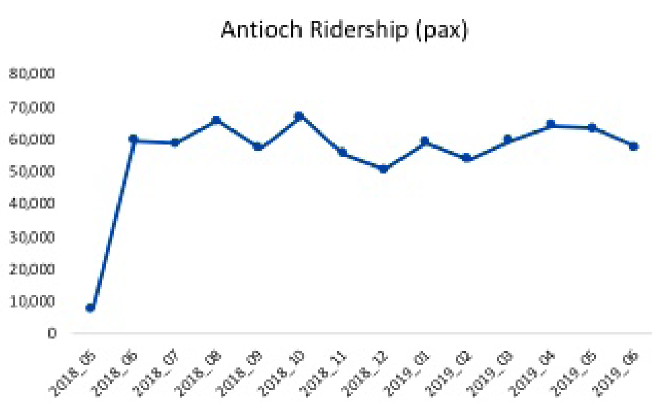


Figure B-2 (cont.)

Variation in BART ridership (2)

U.S. Department of Transportation
Federal Transit Administration

U.S. Department of Transportation
Federal Transit Administration
East Building
1200 New Jersey Avenue, SE
Washington, DC 20590
https://www.transit.dot.gov/about/research-innovation