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Mobility on Demand (MOD) Sandbox Demonstration: DART First and Last Mile Solution

APRIL 2020

FTA Report No. 0164
Federal Transit Administration

PREPARED BY

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U.S. Department of Transportation
Federal Transit Administration

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Office of Demonstration and Innovation
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

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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

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. AGENCY USE ONLY	2. REPORT DATE April 2020	3. REPORT TYPE AND DATES COVERED Final

4. TITLE AND SUBTITLE
Mobility on Demand (MOD) Sandbox Demonstration:
DART First and Last Mile Solution

5. FUNDING NUMBERS

6. AUTHOR(S)
Robert Parks, Senior Manager of Planning Programs
Somayeh Moazzeni, Service Planner II

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESSE(ES)
Dallas Rapid Area Transit (DART)
1401 Pacific Ave.
Dallas, TX 75202

8. PERFORMING ORGANIZATION REPORT NUMBER
FTA Report No. 0164

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Department of Transportation
Federal Transit Administration
Office of Research, Demonstration and Innovation
East Building
1200 New Jersey Avenue, SE
Washington, DC 20590

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
FTA Report No. 0164

11. SUPPLEMENTARY NOTES [https://www.transit.dot.gov/about/research-innovation] [https://doi.org/10.21949/1518336]
Suggested citation: Federal Transit Administration. Mobility on Demand (MOD) Sandbox Demonstration Project: DART First and Last Mile Solution. Washington, D.C.: United States Department of Transportation, 2020. https://doi.org/10.21949/1518336

12A. DISTRIBUTION/AVAILABILITY STATEMENT
Available from: National Technical Information Service (NTIS), Springfield, VA 22161.
Phone 703.605.6000, Fax 703.605.6900, email [orders@ntis.gov]

12B. DISTRIBUTION CODE
TRI-30

13. ABSTRACT
The DART Mobility on Demand (MOD) Sandbox Demonstration provided the opportunity for DART to improve the efficiency of the DART transportation system through innovative partnerships and integration of technology for enhanced service delivery and improved customer satisfaction. This project facilitated collaboration with a microtransit provider and Transportation Network Company (TNC) to provide more transit trip choices for riders in a low-density area that was difficult to serve. DART achieved most of the established goals for the project, which was to increase ridership and replace less-productive fixed-route systems. As a result, in areas in which the service was implemented, ridership increased with less cost, more coverage, and less travel time. However, this unique experience faced challenges that DART was able to resolve successfully. Changes to the system to be more receptive to the use of the technology and the subsequent change in behavior were the biggest challenges that required time and other supportive systems. Also, incorporating carpool service faced some policy limitations that suggested regional collaboration with transit agencies. However, microtransit (GoLink) and TNC integration was successful with some policy direction. This report discusses DART's challenges and successes with the project in planning, marketing, operation, and technology implementation and presents results of a self-evaluation concerning the performance of the GoPass application and GoLink and TNC services and provides lessons-learned information and recommendations for future, similar projects.

14. SUBJECT TERMS
Mobility on Demand (MOD), first/last mile, transportation network company (TNC), microtransit, GoLink, GoPass

15. NUMBER OF PAGES
71

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

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ACKNOWLEDGMENTS

The authors would like to thank the members of the DART MOD Implementation Team who participated in the project and contributed to the development of this report:

- Brandi Stringer, Senior Manager of Marketing
- Kerri Babbitt, Project Manager II-Mobility Services
- Lisa Rising, Analyst- Planning Administration
- Lupe Hernandez, Audio/Visual Specialist
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ABSTRACT

The DART Mobility on Demand (MOD) Sandbox Demonstration provided the opportunity for DART to improve the efficiency of the DART transportation system through innovative partnerships and integration of technology for enhanced service delivery and improved customer satisfaction. This project facilitated collaboration with a microtransit provider and Transportation Network Company (TNC) to provide more transit trip choices for riders in a low-density area that was difficult to serve. DART achieved most of the established goals for the project, which was to increase ridership and replace less-productive fixed-route systems. As a result, in areas in which the service was implemented, ridership increased with less cost, more coverage, and less travel time. However, this unique experience faced challenges that DART was able to resolve successfully. Changes to the system to be more receptive to the use of the technology and the subsequent change in behavior were the biggest challenges that required time and other supportive systems. Also, incorporating carpool service faced some policy limitations that suggested regional collaboration with transit agencies. However, microtransit (GoLink) and TNC integration was successful with some policy direction. This report discusses DART's challenges and successes with the project in planning, marketing, operation, and technology implementation and presents results of a self-evaluation concerning the performance of the GoPass application and GoLink and TNC services and provides lessons-learned information and recommendations for future, similar projects.

EXECUTIVE SUMMARY

In May 2016, the Federal Transit Administration (FTA) announced an $8 million Public Transportation Innovation funding opportunity for a Mobility on Demand (MOD) Sandbox Demonstrations. In October 2016, Dallas Area Rapid Transit (DART) was selected as one of 11 MOD Sandbox Demonstration projects; the DART First and Last Mile Solution project received $1.5 million, most of which was ultimately used for technology, with DART providing operational funding.

The project goals were to improve first mile/last mile (FMLM) access to DART transit for all people including individuals with disabilities, increase transit ridership on DART, improve the experience of transit, provide alternative transportation/multimodal travel options, expand service within certain areas and improve access to jobs, replace ineffective and costly fixed-route transit with MOD services, and improve customer satisfaction. The project also intended to provide same-day service for riders with disabilities who use wheelchair accessible vehicles (WAVs) instead of next-day, demand-responsive service and to comply with the American with Disabilities Act (ADA) through meeting an equivalent level of service requirement.

Through its MOD development process, DART began to collaborate with technology providers; in October 2017, approximately one year after the FTA selection announcement, a pilot MOD test was conducted that proved to be an operational success using DART's GoPass applications (app) and vehicles supplied by a DART contractor.

The evaluation of this project showed that DART improved transit access for all people by implementing MOD using GoLink and Uber. Response and travel times to access the system improved over time and were enhanced through the inclusion of Transportation Network Companies (TNCs). Moreover, MOD and Uber services were added without additional expense to riders.

Results of a MOD customer survey showed major improvements in overall customer satisfaction. MOD extended coverage to areas with little or no transit, which increased overall transit ridership and reduced cost to DART. The performance of TNCs was critical with the furthering of project objectives.

A major lesson learned was to involve all planning and implementation staff in the process as early as possible, especially for software selection. Regular and ongoing meetings of staff well in advance of implementation are necessary for success, and software functionality and early testing are critical. Field testing of the software at the rider and operator levels must occur well in advance to de-bug the system.

The results of this project are beneficial for transit agencies and municipalities planning and implementing MOD. Citizens, advocates, cities, and neighborhoods facing transit cuts will benefit from studying this report. Employers in lower-

density areas seeking transit options for their employees, Chambers of Commerce, and Transportation Management Associations (TMAs) will benefit from this study as they work with their local transit providers, and the results of this project will help researchers study the actual implementation of MOD.

SECTION

1

Introduction

The Dallas-Fort Worth area has experienced explosive growth over the last 30 years (US Census, 2016), and commensurate with that growth is increasing traffic congestion. Although Dallas Area Rapid Transit (DART) has expanded its services significantly to help accommodate the growth, increasing ridership and service has been a challenge (Weinreich et al. 2019).

DART covers a sprawling service area, with bus stops and rail stations remote from jobs and residences, and many residents have particularly acute "first mile/ last mile " (FMLM) problems even when high-frequency rail or bus service are available for part of their trip. The solution to the FMLM problem is critical to support effective transit in peripheral and low-density areas with jobs and residents. DART's demonstration of a solution in its spread-out service area bodes well for other higher-density metropolitan areas. Nearly 28% of all residents and 24% of all DART service area jobs are more than ¼-mile from a bus stop or rail station, so service coverage is a particular problem.

In May 2016, the Federal Transit Administration (FTA) announced an $8 million Public Transportation Innovation funding opportunity for Mobility on Demand (MOD) Sandbox Demonstrations. In October 2016, DART was selected as one of 11 MOD Sandbox Demonstration projects; the DART First and Last Mile Solution project received $1.5 million, most of which was ultimately used for technology, with DART providing operational funding. The DART MOD Sandbox project provided an opportunity to address some of the challenges DART faced.

Project Goals

Project goals represented what DART aimed to achieve through its MOD Sandbox Demonstration and set the foundation for the selection of the project's performance metrics. These goals included the following:

- Improve FMLM access to DART transit for all people, including individuals with disabilities.
- Increase transit ridership on DART in the pilot region.
- Improve the experience of transit.
- Improve information about alternative modes accessing DART.
- Improve transportation/multimodal travel options.
- Expand service within certain areas, expand public transportation coverage, and improve access to jobs.
- Replace ineffective, costly fixed-route transit with MOD services.

- Provide same-day service for riders with disabilities with wheelchair-accessible vehicles (WAVs) instead of next-day demand-responsive service.
- Improve customer satisfaction.
- Comply with Americans With Disabilities Act (ADA) equivalent level of service requirements.

Project Evolution

The DART MOD Sandbox project proposed modifying GoPass, its existing regional mobile application (app), to offer transit riders first/last mile travel options based on price, wait time, travel time, and the ability to pay for the service within the app. Connecting FMLM travel options that were targeted initially included Transportation Network Companies (TNCs), public transit TNC options (e.g., DART On-Call), account-based taxi services, microtransit, bike share, car share, and vanpool and carpool options. Only a subset of FMLM solutions was implemented, as explained later in the report.

In October 2017, the microtransit component of the DART MOD Sandbox Demonstration started with three 40-ft coaches running a three-hour (11:00 am–2:00 pm, Monday through Friday) lunch service in the Plano Legacy West area for Toyota employees only. GoLink was DART's marketing name for the microtransit service. Initial service was to and from Toyota Headquarters to designated eating and shopping areas.

Before implementation of GoLink, the only DART service in this area was one 40-ft coach that ran during morning and afternoon peaks only. DART's GoLink service offered mid-day service to restaurants and shops that previously had not been available. Through its MOD development process, DART collaborated with technology providers, and, in October 2017, it conducted a pilot test in Plano, picking up employees at Toyota and transporting them to restaurants and shops in the Legacy West area.

Prior to and during implementation of the pilot in the Legacy West area, DART learned several lessons that proved valuable to the project. First, extensive in-field testing of the GoPass app had to occur before the microtransit "go-live" date. Problems occurred with the app at the rider/user level and with the tablets used for operator manifests. In some instances, tablets broke down during service hours, requiring a spare vehicle to be in place. In other instances, drivers saw weaknesses in the routing algorithm and overrode them.

Because the DART GoPass Implementation Team had been meeting weekly for some time and included technology experts from the DART Finance Department, representatives from DART service planning and operations, the contractor MV Transit, and routing technology contractor Double Map, quick mobilization was effective in resolving problems. Based on DART's experience, the success of microtransit was highest when all levels of management staff who were expected

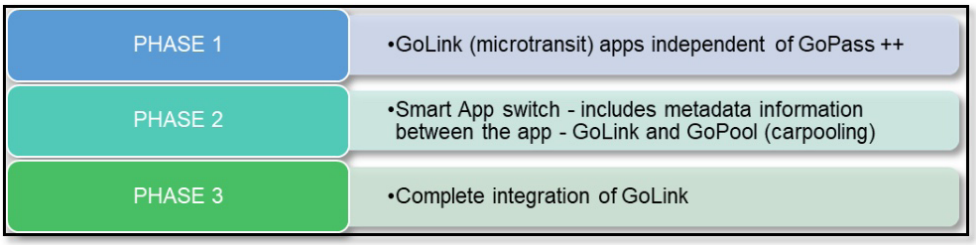
to implement microtransit were involved from inception, including technology contractors.

Because DART's first implementation was limited to one company and a limited area of Legacy West during mid-day hours, unforeseen operational and technological problems could be worked out before a larger microtransit area was attempted. Ultimately, the initial limited microtransit service using DART's GoPass app and vehicles supplied by MV Transit proved to be an operational and technical success, and staff felt ready to expand to other zones and other phases.

As part of this effort, DART upgraded its GoPass regional mobile app to provide seamless access to first and/or last mile services based on wait and travel times as well as cost and geographic location through a phased deployment approach. This approach included the phases described in Figure 1-1.

Figure 1-1

Phases of GoPass app upgrade



The GoPass++ app included all features of the GoPass regional mobile app but was restricted to MOD Sandbox Demonstration pilot test users. GoLink was accessed via the TapRide rider app hosted by DoubleMap, and GoPool was a same-day carpooling app hosted by SpareLabs. GoPool, as it turned out, produced too few drivers to be continued.

Phased integrations were to be accomplished by leveraging the Application Programming Interfaces (API) of key mobility partners and providers.

In March 2018, all-day GoLink service became active in Plano. The noontime Legacy West service between Toyota and West Plano restaurants and shops continued, but a new GoLink zone was added that served all of Legacy West. In addition, the North Central Plano (NCP) DART On-Call (DOC) zone required an advance reservation and served only trips to and from one anchor point.[1] Parker Road. DOC became NCP's GoLink service, and the original DOC zone was expanded to serve an area adjacent to the north known as Chase Oaks, which allowed trips anywhere in the GoLink zone and to Parker Road. Service operated from 5:00 am–8:00 pm Monday through Friday.

Finally, in August 2018, a Far North Plano (FNP) GoLink zone was added, serving a high-income, low-density area with no prior bus service. This zone

[1]A designated DART park-and-ride facility or rail station associated with a given zone.

provides coverage to an area in which traditional home-based commuters are apt to ride to anchor points such as rail stations and park-and-ride facilities, reducing reliance on automobiles. The FNP zone is a high-density, upper-income area in which subdivisions are often walled off from arterial streets, a condition that is considered generally unfavorable to fixed-route transit. Such an area provided a good area in which to test GoLink service supplemented by Uber.

Project Evaluation

DART had been researching and adjusting suburban service since that service began in 1985 (Gomez- Ibanez and Parks, 2017). However, opportunities to better facilitate these FMLM connections were improved significantly in the last few years through the development of enhanced communication and technology infrastructure and new service opportunities such as microtransit and TNCs.

As a result, through the MOD Sandbox project, DART updated its platform within its GoPass app in Phase 3 to provide on-demand travel information across multimodal journeys, enabling a single-source payment and remittance mechanism and collecting traveler information in a single transactional experience. Also, through the MOD Sandbox project, DART successfully integrated new MOD transportation providers and pursued a MOD service to address the FMLM option.

For increasing efficiency and effectiveness through the MOD Sandbox project, DART was very careful to examine and document issues of equity and accessibility. TNC services such as Uber typically use smart phone scheduling to minimize wait times and improve travel times. However, DART's MOD project demonstrated that equivalent service can be made available to all customers, including those without smart phone access, persons with disabilities (especially those requiring mobility devices), and those without no credit card access or who have other banking limitations, as detailed later. This would impact equitable access for all users, regardless of their situation.

Although companies such as Uber, Lyft, and Irving Holdings already had app-based scheduling systems, similar technology did not exist in Dallas for public demand-response services such as DOC, DART's existing microtransit service. These public services depended on scheduling trips via telephone to a dispatch center. To address this technology gap, through the FTA project, DART procured an app that would enable customers to get real-time access and options across providers and permit real-time transit scheduling, booking, and payment to DART or other demand-responsive providers for mixed transit trips according to their transportation needs.

A public transit-operated on-demand app also was essential to ensure that DART could offer mobility on demand equitably without regard to mobility limitations or smart phone or credit card availability. Additionally, by scheduling trips

through the DART app, DART took control of essential data for the National Transit Database (NTD), accounting, auditing, and project evaluation.

As part of this on-demand app, DART used an account-based fare payment module as a financial clearinghouse for revenue settlement for third-party transportation providers. DART customers using this system could leverage multiple payment options, including access to approximately 900 PayNearMe locations at which cash can be loaded onto fare media for use with MOD.

An essential objective of DART's MOD Sandbox project was to negotiate with and integrate private TNCs to provide service to DART customers through the GoPass app. This allowed the TNCs to accept settlement payments based on DART's account-based system and provide trip data required for NTD and project accounting, auditing, and project evaluation.

An independent evaluation of the DART MOD Sandbox Demonstration was conducted under a separate contract with the U.S. Department of Transportation to determine the success of the project in meeting its objectives. DART collaborated with the independent evaluator throughout the project.

The following sections provide more analysis and detailed information on the project and an evaluation of DART's MOD Sandbox project. This report contains a wealth of detail, and it is hoped that it will be of use to those actively seeking to undertake MOD.

SECTION

2

Project Description

The Dallas–Fort Worth area has experienced explosive growth over the last 30 years, and commensurate with this growth is increasing traffic congestion. DART has expanded its services significantly to help accommodate the growth by increasing ridership and service frequency.

As a result of DART covering such a large service area, many residents of the Dallas–Fort Worth area have difficulty completing the first and/or last mile of their commutes, even when high-frequency rail or bus are available for a major portion of their trip. Nearly 28% of all residents and 24% of all DART service area jobs are more than ¼-mile from a bus stop or rail station. This challenge of FMLM access has arguably discouraged many potential riders from choosing public transit.

Opportunities to better facilitate these FMLM connections have significantly improved in the last few years through the development of enhanced communication and technology infrastructure as well as new service concepts such as microtransit and TNCs. As a result, through its MOD Sandbox Demonstration project, DART desired to develop a platform within its enhanced GoPass app to provide on-demand travel information across multimodal journeys, enable a single-source payment and remittance mechanism, and collect traveler information in a single transactional rider experience. DART intended to integrate new MOD transportation providers and pursue a public MOD network to meet the FMLM option.

TNC services such as Lyft or Uber typically use smart phone scheduling abilities to minimize wait times and improve travel times. However, DART recognized its responsibility to serve all customers, including those without smart or cell phone access, persons with disabilities (especially those requiring mobility devices), and those without credit card access or with other banking limitations in addition to the opportunity presented through the availability of multiple modal options based on individual needs.

Through this MOD process, DART first collaborated with technology providers, then conducted a pilot test of the system using available FMLM providers. Over time, DART added other providers on a phased basis, including microtransit, taxi companies, and scooter and bike-share companies.

DART's project upgraded its GoPass regional mobile application to provide seamless access to FMLM services based on wait and travel time, cost, and geographic location through a phased deployment approach. This was accomplished by leveraging the API of key mobility partners and providers.

Although companies such as Uber, Lyft, and Irving Holdings already had app-based scheduling systems, similar technology did not exist in Dallas for public demand-response services such as DOC. These public services depended on scheduling trips via telephone to a dispatch center. To address this technology gap, DART procured an application providing on-demand capabilities to provide customers with real-time access and options for transportation that got them directly to/from their destinations, pairing them with DART and/or other public demand-response providers.

A public transit-operated on-demand approach was essential to ensure that DART and other public transit providers could offer mobility on demand equitably without regard to mobility limitations and smart phone and credit card availability. Additionally, by scheduling trips through the public DART app GoPass++, DART controlled the essential data for NTD requirements and offered customers additional safety and security afforded by background checks, higher levels of training, and more uniform insurance that may not be available with some TNCs.

The DART project also used DART's new account-based fare payment module to function as a financial clearinghouse for revenue settlement for multiple third-party transportation providers. DART customers using this system had the ability to leverage multiple payment options including bank cards, internet payment services (Apple Pay, Android Pay, Samsung Pay), cash loading through PayNearMe integration, and other emerging payment options for unbanked persons.

An objective of DART's MOD project was negotiating agreements with third-party mobility providers such as Uber, Lyft, and bike-share companies to accept settlement payments based on DART's new account-based system and to address data and safety requirements of transit providers.

After developing the technologies, DART conducted a one-year pilot test of the upgraded regional mobile app and integrated payment system. It measured its success through a self-evaluation based on the performance metrics and expected outcome listed below that address the project goals agreed on by DART and FTA.

Performance Metrics and Expected Outcomes

In line with project goals, the following performance metrics were used to measure the impact of the project:

- Ridership change on selected routes that are affected by the app (expected to increase)

- Perception of improved FMLM access mobility, wait time, and travel time by overall passengers and passengers with disabilities (expected to improve)
- Travel time for access and egress travel to the DART transit system based on GoLink (expected to decrease)
- Average distance of travel for GoLink users (expected to decrease)
- A measure of the area considered accessible via DART with and without app (expected to increase)
- Cost per rider of DART bus service in areas replaced by MOD service (expected to improve)
- Perception of response time, travel time, and fare paid by ADA passengers in the Plano area (expected to be equivalent)
- Number of WAV trip requests (expected to increase)
- Number of trips provided with WAVs (expected to increase)
- Average travel distance of general population and persons with disabilities making similar trips (expected to be equivalent)
- Average fare of the general population and persons with disabilities making similar trips (expected to be equivalent)
- Reported customer satisfaction of DART riders (expected to improve)

SECTION

3

Project Evolution

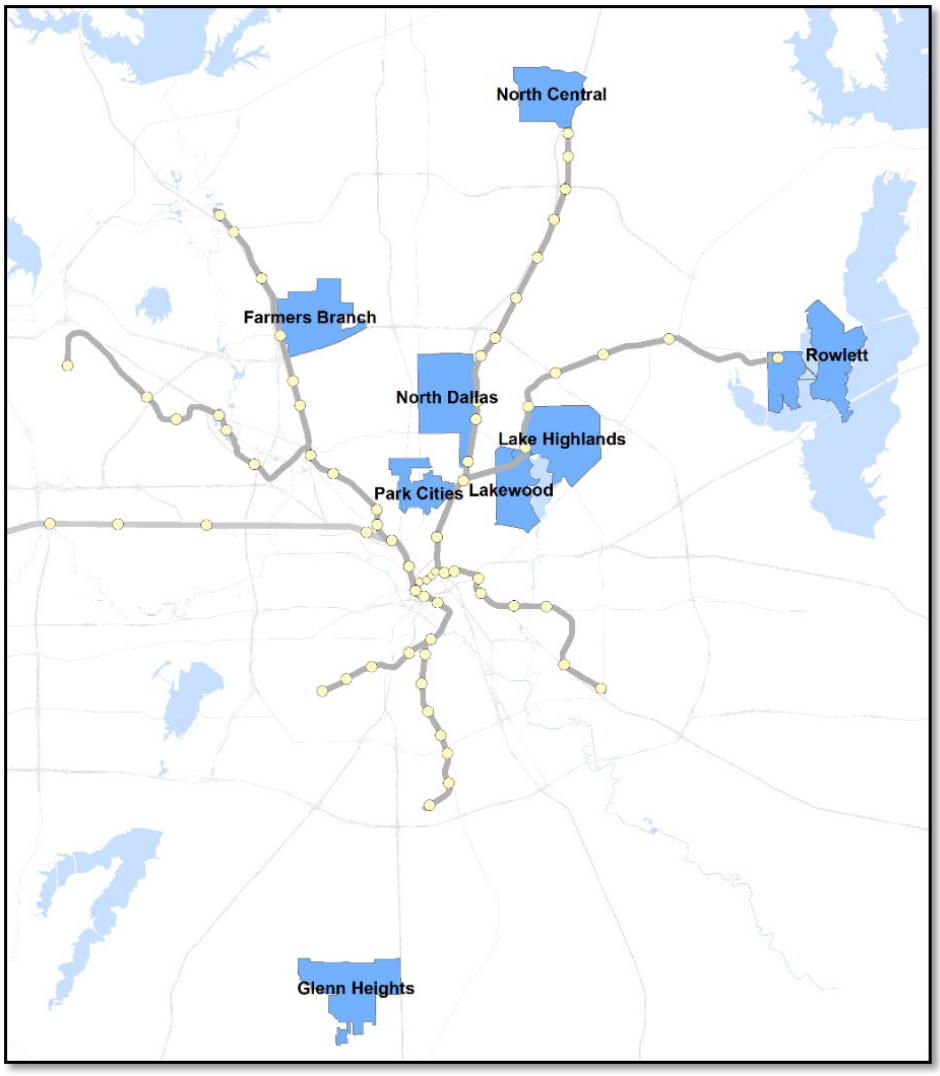
This section discusses the implementation of the DART MOD Sandbox Demonstration and describes how the project progressed and changed by revising elements and components as necessary to addresses challenges and issues and to leverage opportunities.

Service Planning and Deployment

From a service planning perspective, the DART MOD Sandbox project evolved out of a general market paratransit program called DART On-Call (DOC). The original DOC zones are shown in Figure 3-1; North Central Plano (NCP) was the first zone of interest for the DART MOD project.

Figure 3-1

DOC program zones



DOC was available by subscription and reservation from seven days to one hour in advance or by walk-up. During peak travel times, service was available from all points in the DOC zone only to rail stations and park-and-ride facilities, with intrazonal travel allowed during mid-day and evening periods. No app was available to book trips, and capacity was capped at one or two vehicles allocated to each zone, which limited the size of zones to roughly six square miles.

Two locations for implementation of GoLink for the project were debated—the Inland Port and Plano. Factors in determining which location to select included density of employee base, lack of DART fixed-route service, and convenient high-capacity freeway access. The GoLink location chosen for the pilot was Plano.

As noted, in October 2017, DART began its initial noontime GoLink on-demand service in an area of Legacy West. Although the service operated only from 11:00 am–2:00 pm, limited service was a necessary step in the development of MOD. Up to that point, staff were concerned that the initial MOD service would either be completely overwhelmed by demand, pushing budget limits and available vans, or not be ridden at all, leaving the MOD concept in question. In fact, technical issues such as the routing algorithm, software deployment, and tablet hardware, rather than ridership issues, proved more of a challenge. Ridership was significant the first week and continued to grow. As detailed later, despite these initial problems with technology, noontime service ultimately demonstrated the workability and practicality of the technology.

As a result of this technological and ridership success, DART decided to extend the GoLink service to the Legacy West zone in March 2018 and converted the NCP DOC to GoLink with expanded service coverage. DART also added the Far North Plano (FNP) GoLink zone in August 2018, as shown in Figure 3-2.

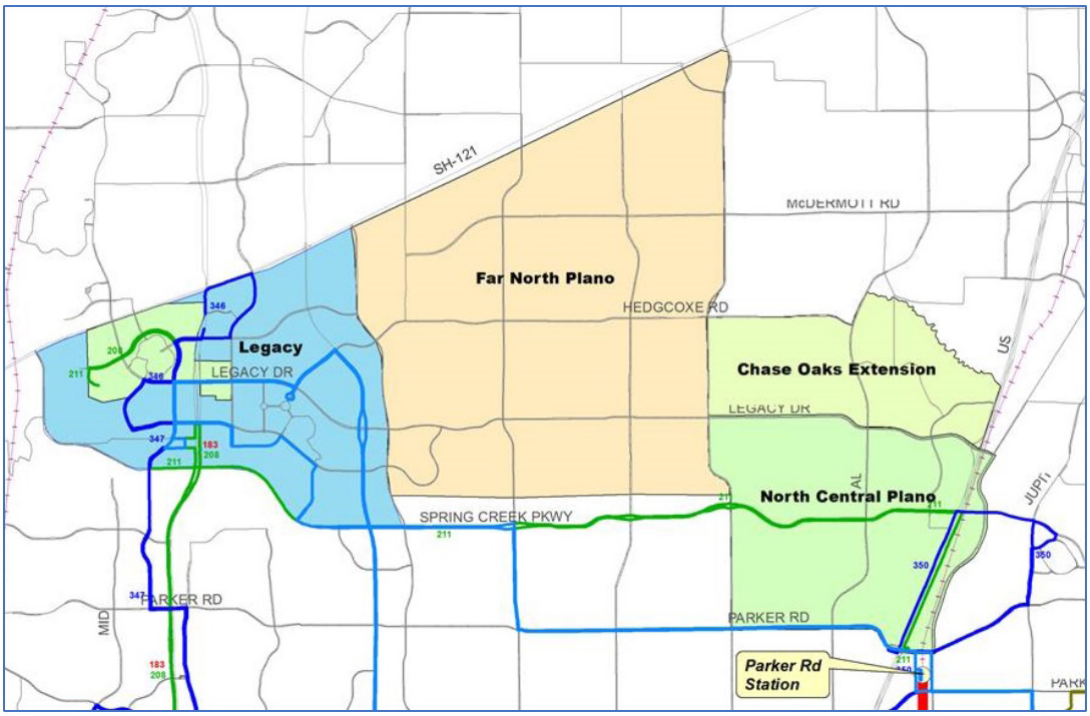


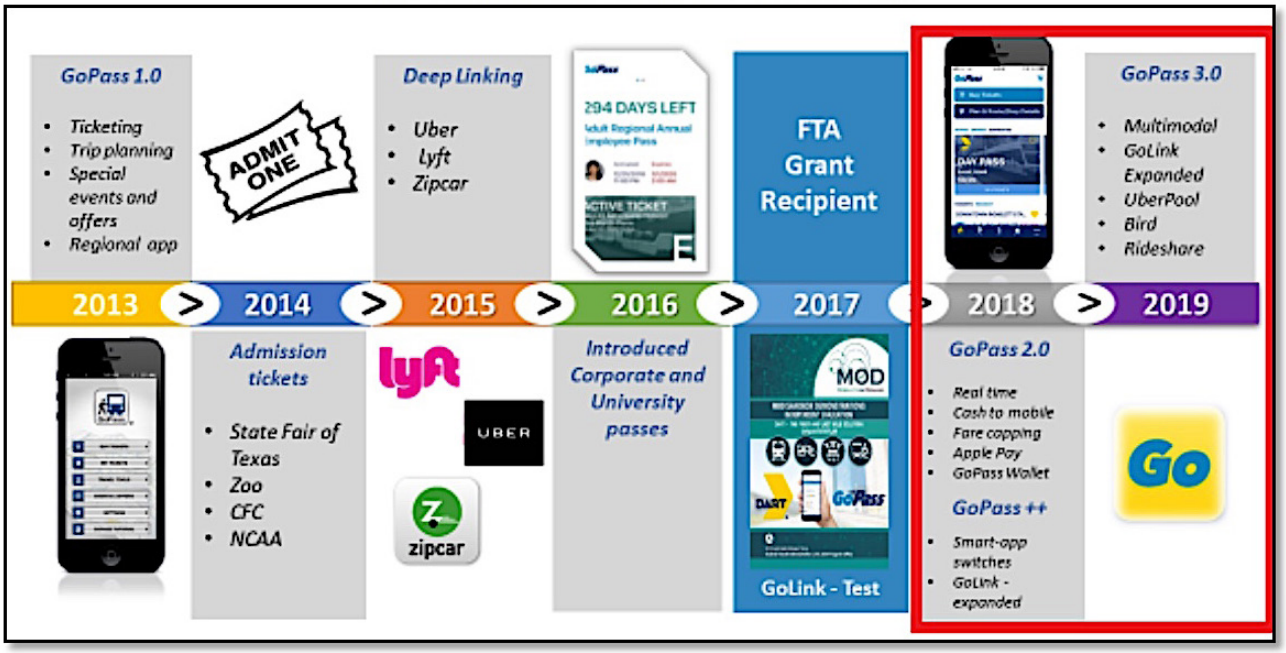
Figure 3-2

DART GoLink zones, August 2018

Operation and Technology Planning and Deployment

Figure 3-3 shows the evolution of DART's GoPass system, from development in 2013 to the current GoPass 3.0. It is important to not view GoLink or other components of the MOD Sandbox Demonstration project as items beginning in 2016 but, rather, as part of a GoPass continuum.

FTA funding enabled the evolution of DOC to the superior GoLink system and also spurred the development of GoPass 2.0, GoPass ++, and GoPass 3.0, with crucial features such as real time, cash-to-mobile, Apple Pay, and GoPass Wallet. It is unlikely that this development would have occurred without FTA funding. Originally intended to be part of the app, GoPool proved to be technologically feasible but was discarded due to the inability to recruit rideshare drivers. Instead, better links were sought with TryParkingIt, the North Central Texas Council of Governments (NCTCOG) rideshare app scheduled for an upgrade to feature more dynamic, shorter-term features.



Note: Accomplished actions highlighted in red.

Figure 3-3

Evolution of DART GoPass app

Prior to the FTA project, the NCP DOC was the only general-market paratransit service operating in Plano, and large areas of Plano were without any transit service. Reservations could be made by calling a reservationist one hour up to seven days in advance to schedule a trip. Riders could also "walk on" the bus at the Parker Road station. Drivers manually kept track of walk-ons to be added to the manifest later or called them into Dispatch when they could. Subscriptions were allowed.

In October 2017, when DART started GoLink, riders could book their own on-demand door-to-door trips using the TapRide mobile app from DoubleMap, DART's MOD software provider. The TapRide app was heavily promoted in preference to having customers call DART Reservations or walking onto the vehicle. Marketing was targeted to Toyota employees. DART later migrated to integrated GoLink service within GoPass, obviating the need for TapRide.

Operations staff were trained on how to download and use the TapRide app to assist Toyota employees with scheduling trips. Operations staff were on the ground for a week to promote the GoLink lunch service. Drivers also handed out brochures and promoted the TapRide app to riders. Initial technology issues such as a rider pickup algorithm and software deployment resulted in additional vehicles to serve Toyota and the designated eating/shopping areas. Later, these technology issues were resolved.

Contractor managers, reservationists, and dispatchers were trained in their respective areas of the MOD technology. Driver training consisted of classroom training and in-field, behind-the-wheel training. Classroom training, provided by DART staff, was used to familiarize drivers with the new driver technology, and field training was used to familiarize drivers with the service area and experience real-time use of the driver app. During training, DART or contractor staff were on each vehicle during training to answer driver questions and assist with any technology issues.

As noted, making provisions to accommodate initial ridership on the Toyota lunch service was a subject of much discussion and anxiety among the MOD Implementation Team, so two protection vehicles were on standby at DART's Northwest Plano park-and-ride facility for the first two weeks of service. These drivers were called upon a few times due to vehicle breakdowns. DART reduced the number of protection vehicles to one during the last two weeks of October 2017 and removed them completely after November 3, 2017, as vehicles and tablets became more reliable and designated vehicles proved to be adequate for the loads.

MOD Conversion and Expansion

On March 12, 2018, DART's NCP DOC zone was expanded and converted into the North Central Plano/Chase Oaks GoLink zone. The Parker Road station remained the anchor station for this zone, and operating hours remained the same (5:00 am–8:00 pm Monday through Friday).

As was done for the lunchtime service to Toyota, driver training for the NCP zone consisted of classroom and behind-the-wheel time. Because the ability to book trips via the TapRide app was new to riders in this zone, drivers were shown how to book a trip via the TapRide app so they could further assist riders with the conversion from DOC to GoLink.

Drivers were a large part of marketing of this particular conversion. For weeks prior to the NCP zone conversion, DOC drivers promoted the TapRide app and passed out brochures. Operations and planning staff were also on the ground and on the vehicles for the first week of NCP GoLink service.

Ridership in NCP was good before the conversion to GoLink, but the hope was that ridership would increase after conversion to GoLink. In anticipation of increased ridership, a "protection" vehicle was added to the zone for 14 hours per day (5:30 am–7:30 pm Monday through Friday). This protection vehicle is still in service today.

The Toyota lunch service was expanded on March 26, 2018, to the entire Legacy West zone and was open to all riders. The anchor station for the Legacy West zone is DART's Northwest Plano park-and-ride facility.

Of the three Plano zones, Legacy West has always had the highest number of TapRide app bookings. Drivers were already familiar with the driver app, so field training was conducted only to familiarize drivers with the expanded zone.

On August 27, 2018, the third and final Plano GoLink zone, Far North Plano, was implemented. The Parker Road station is the anchor station, with operating hours of 5:00 am–8:00 pm Monday through Friday. There was no transit service in FNP until GoLink was established. GoLink drivers received classroom and extensive field training for this zone. DART operations and planning staff were on the ground and on the vehicles to promote GoLink and DART's TapRide app.

Managing Growth

As the concern about ridership diminished and GoLink ridership increased, adding more vehicles or drivers was not an option, and wait times increased to beyond DART standards. In response, DART contracted with UberPool to give riders another MOD option while ensuring that continuation of accessible vans would provide equivalent service. UberPool offered pooled trips in the three Plano zones at DART rates, and DART subsidized the difference between the DART rate and the actual cost of the Uber trip. The results showed the addition of UberPool brought net new riders rather than just migrating vanpool riders to UberPool.

Marketing Planning and Execution

DART's Marketing Department was included on the MOD Implementation Team from project inception, which proved beneficial in examining the GoPass app, including GoLink-affiliated UberPool and GoLink operated by MV Transit, under the customer experience lens. This experience ranges from the in-app experience to the on-board vehicle experience and includes post-trip feedback.

Figure 3-4

DART-branded GoLink vehicle

Pilot Recruitment

Pilot participant recruitment was one of Marketing's first major initiatives. As with most pilots, the focus was on one small geographical area. Although it may seem easier for recruitment, it proved challenging because there was a smaller pool from which to recruit. DART's goal was to have 200 active participants that would provide regular feedback when polled.

Much of the focus was on major employers in the area, which provided a concentrated effort and allowed a bigger impact in a short amount of time. Targeted employers included Toyota, Liberty Mutual, JP Morgan Chase, Frito Lay, and Bank of America. On-site information sessions were conducted, often in conjunction with other corporate events. DART also used posters and other print materials and e-blasts and constructed a website with information on the pilot and a digital registration form.

In addition to corporate efforts, DART recruited participants onboard vehicles through both a printed information card directing people to register on the website and one-on-one intercepts during which DART hand-registered participants. A monthly drawing for a DART Monthly Pass ($96 value) was also offered as an incentive to register.

Figure 3-5
GoLink recruitment brochure

Outreach and Education

The MOD pilot was a completely new experience for area transit riders, requiring DART to make people feel comfortable using the app and the services. As such, DART used many traditional marketing approaches but also employed more targeted approaches. Efforts included:

- Printed materials with service highlights and maps
- Windscreens (posters) advertising the project at anchor point stations
- Station intercepts by DART personnel ("feet on the street")
- Meetings with local businesses in service zones to promote service and the MOD pilot
- Enlistment of DART staff from departments outside Marketing to assist with marketing GoLink in the three Plano zones, including riding along, assisting riders to use the app, download questions, and book trips and providing general information

- Covering the pilot at all public meetings in applicable areas of Plano
- Attending community events such as neighborhood association meetings

Figure 3-6

GoLink table at Toyota

Marketing and Advertising Strategy

As part of its service and app promotion, DART developed a comprehensive marketing plan aimed at reaching employers, employees, and residents in key geographic areas. In addition to new rider marketing, transit center advertising, use of DART social media, and publishing of digital newsletters, posts were made in multiple local print and digital publications. Much of the paid media focus was on local newspapers through creating awareness through print ads and editorial content in publications targeting Plano residents. Through print and digital advertising, social media, and a significant public relations effort, DART generated more than 100 million media impressions.

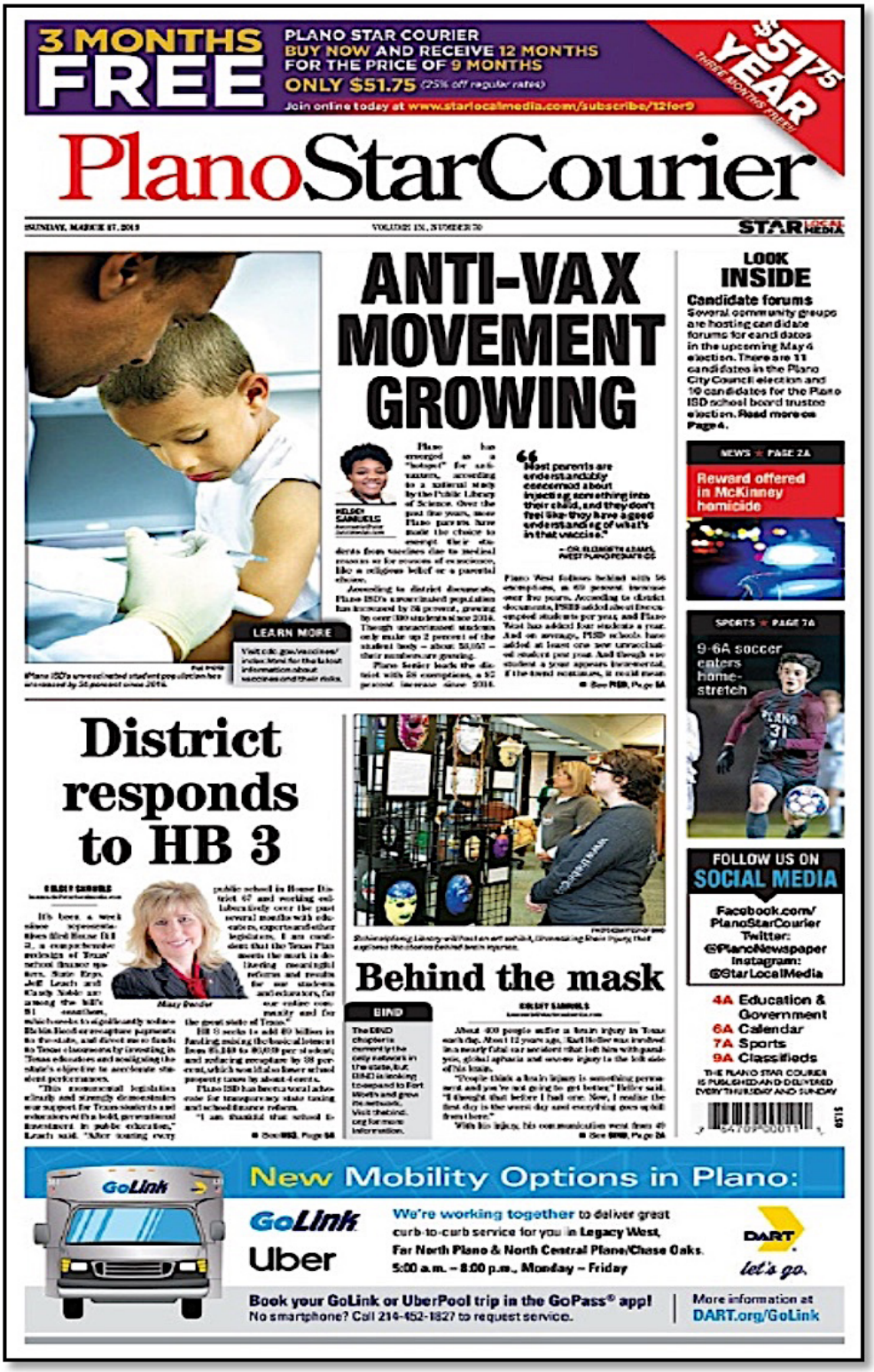


Figure 3-7

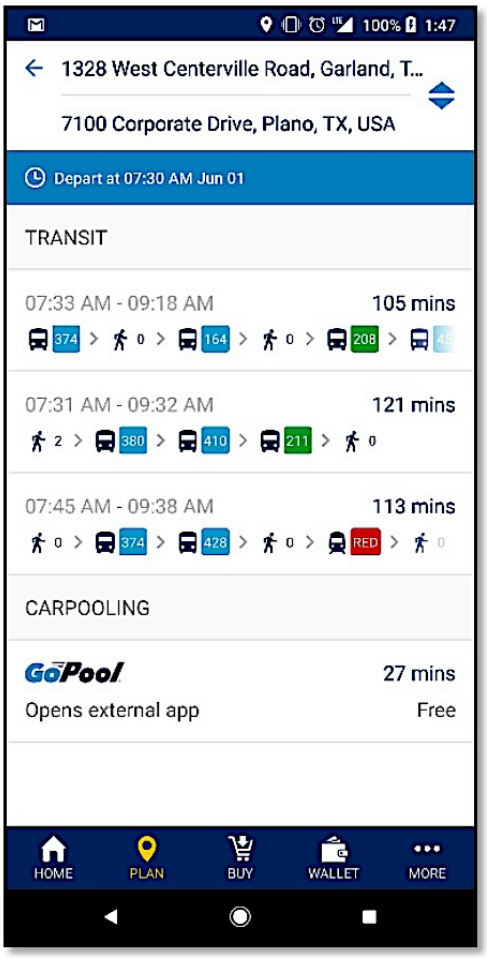
Community newsletter advertising

GoPool Integration

GoPool was a dynamic carpooling project designed to find carpool partners to share the ride to their workplace. Initially tried in two other areas, it was anticipated that GoPool would be a pilot rideshare program under DART's GoPass app, intended to serve the Plano pilot area. GoPool was integrated into the GoPass smart phone app to allow users to route plan, route match, book, and pay for carpool trips. Like DART's vanpool program, GoPool targeted work commuters with a recurring daily commute.

Figure 3-8

GoPool option in GoPass app



Objectives

The main objective of GoPool was to facilitate work travel for single-rider commuters between low-density suburbs and employers. Despite the number of services DART offers, there was no alternative service for single-occupancy vehicle (SOVs) commuters who live beyond the DART service area, with the notable exception of the DART vanpool program.

Since 1995, DART has provided vanpool service for transit patrons whose commutes begin or end within the DART service area. Vanpool is a public transportation mode eligible for FTA funding, with passenger fares covering 55% of the cost. Vanpools offer passengers a shared-ride option where bus or rail services do not exist or are impractical. Vanpool ridership increased since FY 2017 and provided 611,484 trips in FY 2019. The minimum passengers required for a vanpool is six, with a two-month grace period for five passengers to find a sixth.

Most existing vans that have vacancies are subsidized by an employer; only employees of that employer can ride the van. Many vans in the project are formed based on similar shift times among commuters in the van, which makes organizing a van difficult for workers not working standard shifts. GoPool sought to fill this vanpool gap by bringing together riders and drivers within a 24-hour time span.

Technology

The project was managed through a "back office" provided through Spare Labs, a Vancouver-based software company that also assisted with GoLink. With the back-office website, the manager was able to set up a "service" by geofencing any area within the Dallas Metroplex to allow the algorithm to match riders and drivers. Through internal testing with the members of the MOD team, employees in the Finance/Technology, Service Planning, and Operations departments, and the operations contactor were matched; the objective was to ensure that the algorithm matched two people going in the same direction at similar times. After many testing rounds and support from Spare Labs, the payment portion was setup through PayPal, through which riders would pay the driver a flat fee of $2.50 for a ride in exchange for wear and tear, gas, and use of the vehicle.

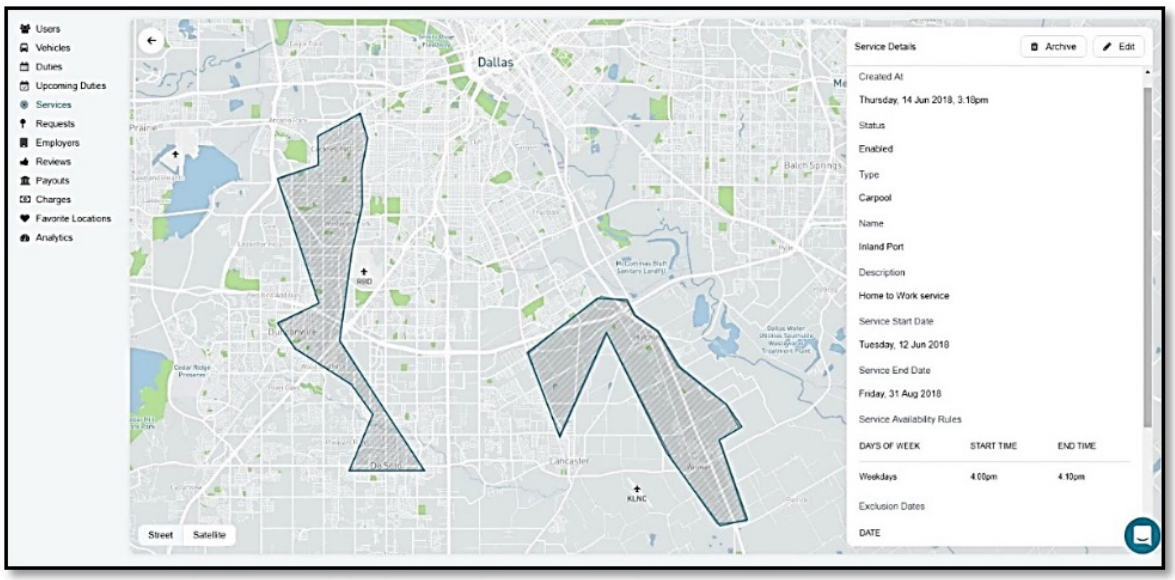


Figure 3-9

Example of "back office" website in which services can be created to match possible carpoolers

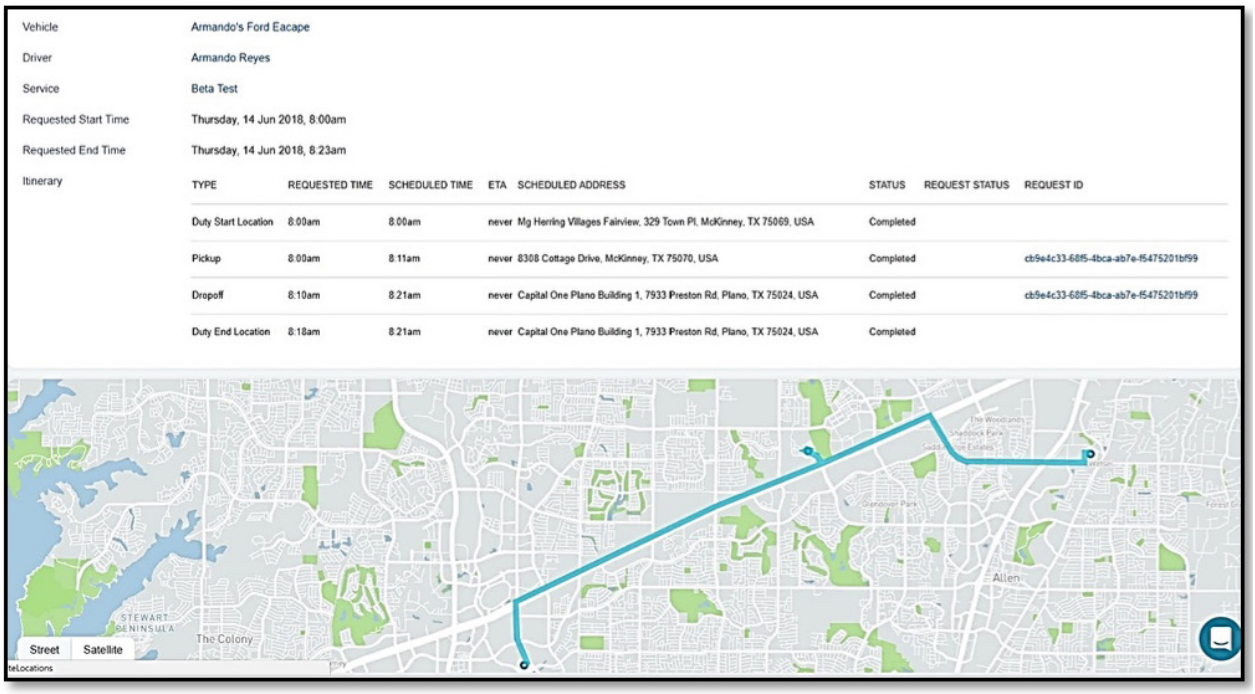


Figure 3-10

Example of "back office" website in which services can be created to match possible carpoolers

Figure 3-11

Example poster of MOD options for GoLink and GoPool for Amazon Fulfillment Center south of Dallas

UberPool Non-Dedicated Microtransit

Since 2000, DART's experience with providing an earlier version of on-demand service—DOC in small geographic zones around DART rail stations—rarely averaged much more than 2.5 passengers per revenue hour with a dedicated, contracted fleet of vehicles. To control the budget, the number of revenue hours was normally capped by limiting service in each zone to one or two vehicles. When demand was high, wait times increased substantially.

Subsidy per boarding is calculated by dividing the cost per hour for service by average total passengers carried in one hour. For typical on-demand service, the cost per trip often was $15–19 per trip, and subsidy per trip averaged $13–17, which DART deemed too high for a sustainable, expandable FMLM on-demand service. Due to budget constraints, DOC had limited growth and market potential.

When DART submitted its FTA application, it anticipated implementing a more modern microtransit service scheduled through a mobile application to address FMLM service in small zones surrounding rail stations. The microtransit app was to be integrated with DART's GoPass mobile application and offer a higher level of service than DOC. Service goals and objectives included the following:

- 10-minute average wait time
- Ride time no more than twice the direct ride time
- Equivalent access for persons with disabilities, the unbanked, and those without smart phones
- Lower cost per boarding, approaching an average of less than $10
- High customer satisfaction

The DART Sandbox project anticipated supplementing a limited dedicated wheelchair-accessible fleet with non-dedicated vehicles provided by taxi companies or TNCs such as Uber or Lyft. It was expected that by using taxis and TNCs, DART could provide shorter wait times and higher service levels without the cost of committing to a larger dedicated fleet. In 2018, DART conducted a solicitation seeking TNCs or taxi providers willing to offer a shared-ride service in Dallas as part of the DART GoPass Sandbox project. Prior to this project, Uber, Lyft, and taxi providers did not offer shared-ride service.

In the solicitation, DART sought a provider that would allow DART customers to obtain shared-ride service through the trip planner in the GoPass app without the need to download a separate TNC app. This meant that the request for the shared-ride trip would be communicated with the TNC through the API. All data were anticipated to be collected within the DART GoPass app rather than requiring the TNC to provide it from their app.

DART received two proposals—one from Uber, which offered UberPool, and one from Irving Holdings, the primary regional taxi provider. Irving Holdings offered its I-Cabbie booking tool as the scheduling app; however, ultimately, it was determined that this app was not a shared-ride scheduling system. Uber proposed to use its UberPool product for this project, and, based upon its willingness to offer shared-ride service, DART initiated negotiations with Uber.

After significant and lengthy negotiations, it was determined that the APIs that DART had anticipated using with GoPass were not yet technically feasible using the UberPool app, as they were designed to work with UberX, but not UberPool.

Ultimately, DART agreed use a deep link from GoPass to allow customer access to UberPool. The customer would enter the origin and destination within the GoPass trip planner, and if the origin and destination were within a GoLink zone, he/she was offered UberPool as an option for DART's GoLink microtransit service.

DART and Uber initiated the new service in March 2019 with the six original GoLink Zones, including the MOD Sandbox Demonstration Plano zones.

DART originally requested full data for each trip, including detailed latitude and longitude coordinates, individual trip distances, trip times, and performance by zone; however, Uber did not agree to provide detailed data for individual trips based on its concern with protecting customer confidentiality. It did, however, agree to provide summary data by week by identifying the transit stop at which customers were picked up or dropped off and providing trip summaries by time periods each week, including trip miles, trip times, wait times, passengers carried, number of trips operated, and fares collected where provided. Uber also provided heat maps of origin and destination locations that showed general activity patterns throughout the zones.

SECTION

4

Evaluation

This section presents the results of a DART self-evaluation of the MOD Sandbox Demonstration project in conjunction with the USDOT-sponsored independent evaluation based on the performance metrics contained in Section 2.

Data Sources

An evaluation of the performance of the MOD project using quantitative and qualitative data was conducted. DART administered online surveys and two onboard surveys and collected activity data. The first onboard survey was conducted February 12–21, 2019, with 255 riders surveyed. In total, 13% of those surveyed were in FNP, 41% were in Legacy West, and 46% were in NCP.

Table 4-1

Frequency Distribution of First Onboard Survey in Plano Zones

Plano Zones	Number of Responses	Distribution Percentage	Riders with Disabilities	Distribution Percentage
FNP	34	13%	2	10%
Legacy West	104	41%	9	43%
NCP	117	46%	10	48%
Total	*255*	*100%*	*21*	*100%*

The second survey was conducted April 8–17, 2019, with 196 riders surveyed in the three Plano zones. Most surveys completed were in NCP.

Table 4-2

Frequency Distribution of Second Onboard Survey in Plano Zones

Plano Zones	Number of Responses	Distribution Percentage	Riders with Disabilities	Distribution Percentage
FNP	24	12%	0	0%
Legacy West	82	42%	3	43%
NCP	90	46%	4	57%
Total	*196*	*100%*	*7*	*100%*

In addition to these surveys, DART used activity data from two platforms developed for the GoLink system, TapRide and Spare Platform. These platforms include data on scheduled and requested pick-up and drop-off times and addresses, number of riders per trip (adult, infant, child, youth, older adult, student, person with disabilities, veteran), number of riders per trip with special requests (stroller, wheelchair, child seat ages 0–3, child seat ages 4–10, service animal), GoLink zones, and cancellation reasons. These data provided information on origin, destination, estimated travel time, time and date, zone, number of riders per trip, reservation methods, riders with special request, etc. The platforms are also designed to show hotspots of drop-off and pick-up addresses that can be zoomed for any further decisions.

Performance Metrics Themes

This section outlines the following performance metric themes used to analyze and evaluate the performance of the MOD Sandbox Demonstration components and services:

- FMLM Access
- Response Time
- Travel Time
- Fare
- Customer Satisfaction
- Transit Access Area
- Ridership Change
- Subsidy per Rider
- Operating Costs

Results are provided for both the GoLink system and UberPool separately and for a comparison between the two when the data were available. This section includes analysis for all users in Plano zones; the analysis for riders with disabilities includes only riders who indicated on the survey their need for a wheelchair, cane, or walker.

FMLM Access

DART's goal was to improve FMLM access to DART transit for all people, including individuals with disabilities, when planning for the MOD project. To understand the impact of the project on this goal, DART conducted surveys in Plano zones that incorporated questions to evaluate access. Those surveyed were asked to rate their access to the DART system on a scale of 1 to 5 before and after GoLink implementation and their access to DART bus stops, transit centers, and light rail stations and to DART's overall bus and rail system.

Figure 4-1 shows the results of the survey for access to DART bus stops, transit centers, and light rail stations for all users in Plano zones. As shown, those rating access as poor or very poor decreased after GoLink implementation, and those rating access as good or excellent increased. Before implementation of GoLink, only 58% rated their experience as good or excellent (4 or 5), whereas after implementation, 91% rated it as good or excellent—an increase of 57%—indicating that their access to bus stops, transit centers, and light rail stations had improved significantly. Also, almost 18% rated their access as poor or very poor before implementation, but after implementation, only 1% rated it as poor or very poor. The same improvement was shown for "average" raters.

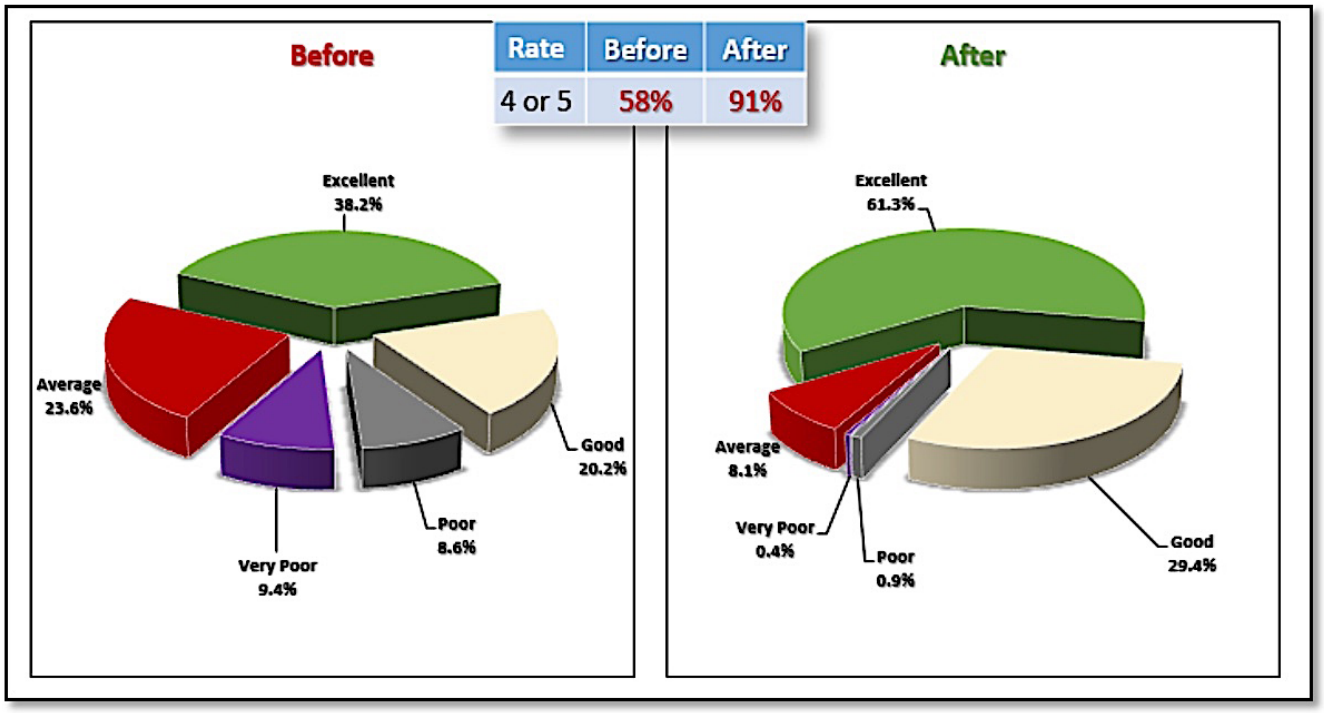


Figure 4-1

Ratings of access to DART bus stops, transit centers, and light rail stations before and after GoLink by all users

Table 4-3

Ratings of Access to DART Bus Stops, Transit Centers, and Light Rail Stations Before and After GoLink by All Users

Rate	Before GoLink	After GoLink
Excellent	38.2%	61.3%
Good	20.2%	29.4%
Average	23.6%	8.1%
Poor	8.6%	0.9%
Very Poor	9.4%	0.4%

The survey also was intended to evaluate project performance among riders with disabilities, including those who need a wheelchair, cane, or walker. The survey showed that among this group, none rated their access as poor or very poor after GoLink implementation, and the good or excellent access rating increased by 53%.

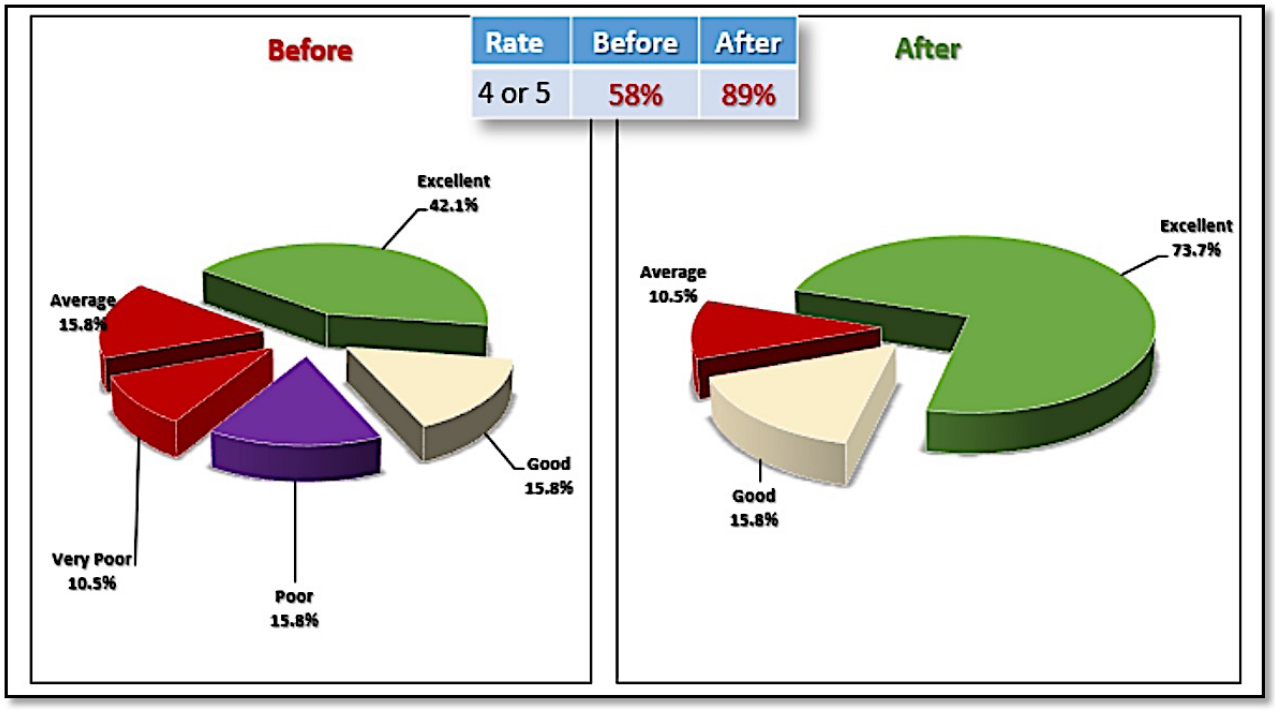


Figure 4-2

Ratings of access to DART bus stops, transit centers, and light rail stations before and after GoLink by riders with disabilities

Table 4-4

Ratings of Access to DART Bus Stops, Transit Centers, and Light Rail Stations Before and After GoLink by Riders with Disabilities

Rate	Before GoLink	After GoLink
Excellent	42.1%	73.7%
Good	15.8%	15.8%
Average	15.8%	10.5%
Poor	15.8%	0.0%
Very Poor	10.5%	0.0%

The survey asked riders to rate their overall access to the bus and rail system, with results showing improved access after implementation of the GoLink system for all users and riders with disabilities. As shown in Figure 4-3 and Figure 4-4, good or excellent ratings among all users increased by 46% after GoLink implementation, and ratings of riders with disabilities increased by 54%. No riders with disabilities rated their access to bus and rail as poor or very poor after GoLink was implemented in their zones. One reason for the better rating might be that DART paratransit[2] system requires a one-day advance reservation, but GoLink provides same-day scheduling services.

[2]DART Paratransit is an origin-to-destination, curb-to-curb public transportation service for people with disabilities who are unable to use DART's fixed-route buses or trains (DART, 2019).

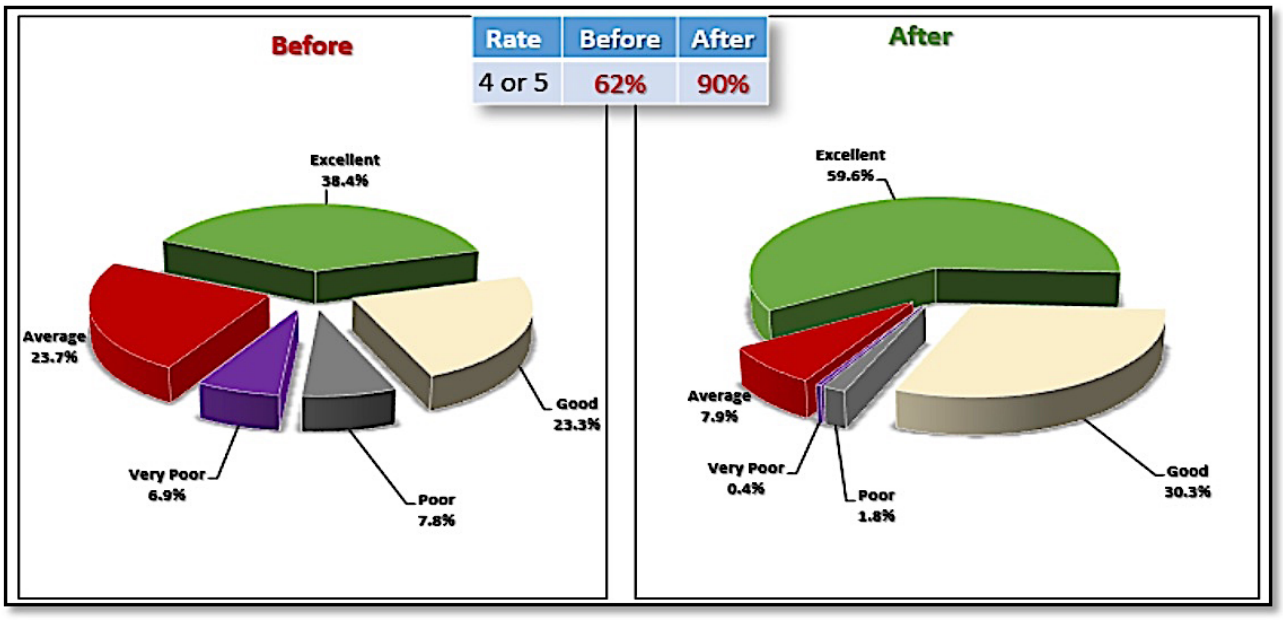


Figure 4-3

Ratings of access to DART's overall bus and rail system before and after GoLink by all users

Table 4-5

Ratings of Access to DART's Overall Bus and Rail System Before and After GoLink by All Users

Rate	Before GoLink	After GoLink
Excellent	38.4%	59.6%
Good	23.3%	30.3%
Average	23.7%	7.9%
Poor	7.8%	1.8%
Very Poor	6.9%	0.4%

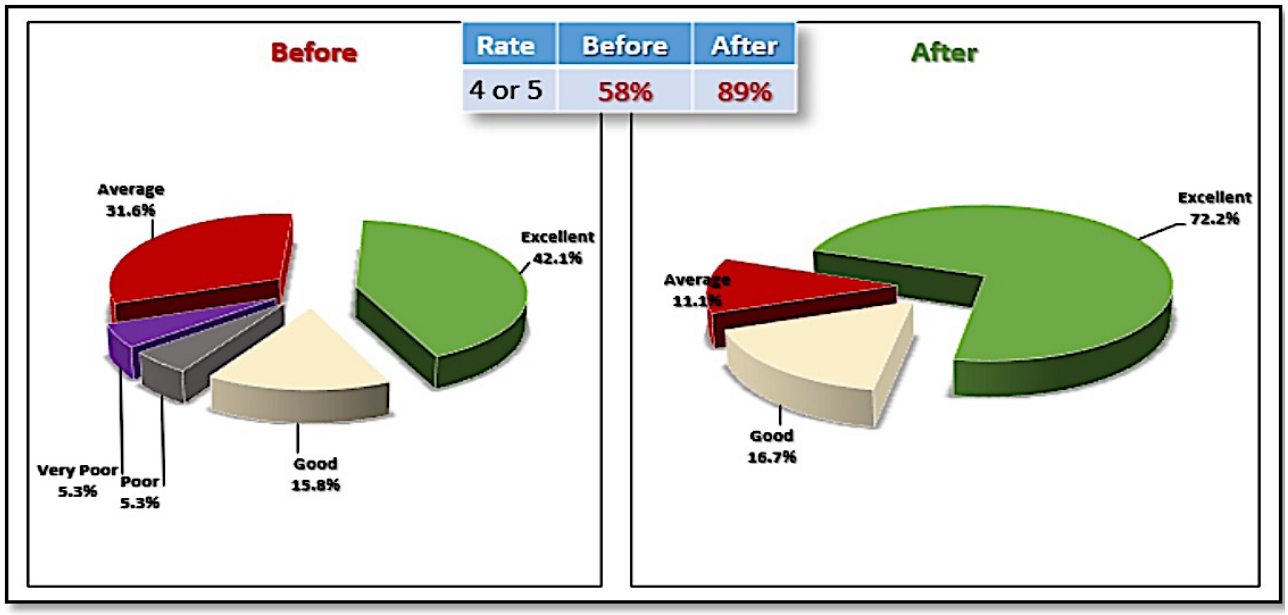


Figure 4-4

Ratings of access to DART's overall bus and rail system before and after GoLink by riders with disabilities

Table 4-6

Ratings of Access to DART Overall Bus and Rail System Before and After GoLink by Riders with Disabilities

Rate	Before GoLink	After GoLink
Excellent	42.1%	72.2%
Good	15.8%	16.7%
Average	31.6%	11.1%
Poor	5.3%	0.0%
Very Poor	5.3%	0.0%

Response Time

One of DART's MOD Sandbox goals includes improving the transit experience for all users by improving service through reduced response times. DART is required to provide riders with disabilities with equivalent service. Review of activity data from the SpareLab platform shows that during April 2018–March 2019, DART provided service with an average response time of 8 minutes for all Plano zones. The response time in Legacy West was 5 minutes , FNP was 13 minutes, and NCP was 10 minutes (Figure 4-5).

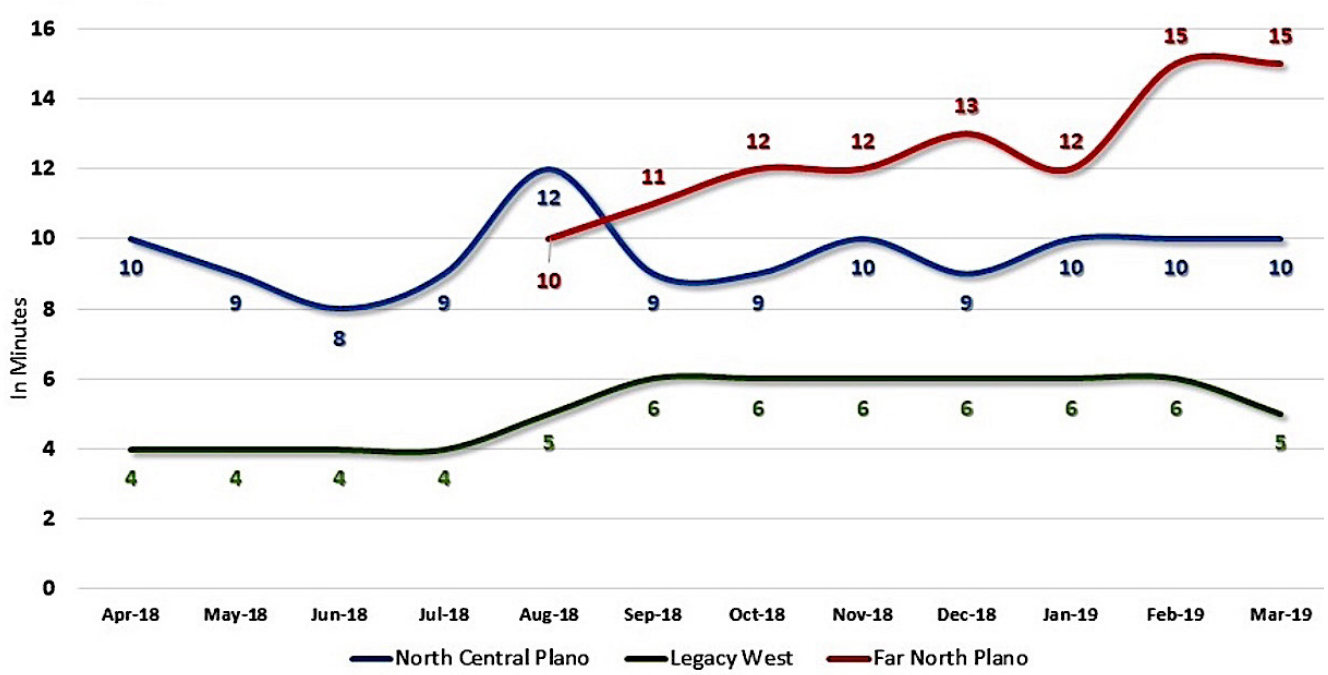


Figure 4-5

GoLink average response time for all Plano zones, April 2018–March 2019

Table 4-7

GoLink Average Response Time for All Plano Zones, April 2018–March 2019

Zone	Average Response Time
Legacy West	5 min
North Central Plano	10 min
FNP	13 min

One reason for the higher response times for the FNP and NCP zones is the location of the anchor points in each. In FNP and NCP, the anchor point is Parker Road station, and the Legacy West anchor point is the Plano park-and-ride facility. Parker Road station is located outside and far from FNP and NCP, and the North West Plano park-and-ride facility is located inside the Legacy West zone. This implies longer trips for FNP and NCP and shorter trips for Legacy West. Figures 4-6, 4-7, and 4-8 show the location of the anchor points in each zone.

Figure 4-6

Anchor points in Legacy West zone

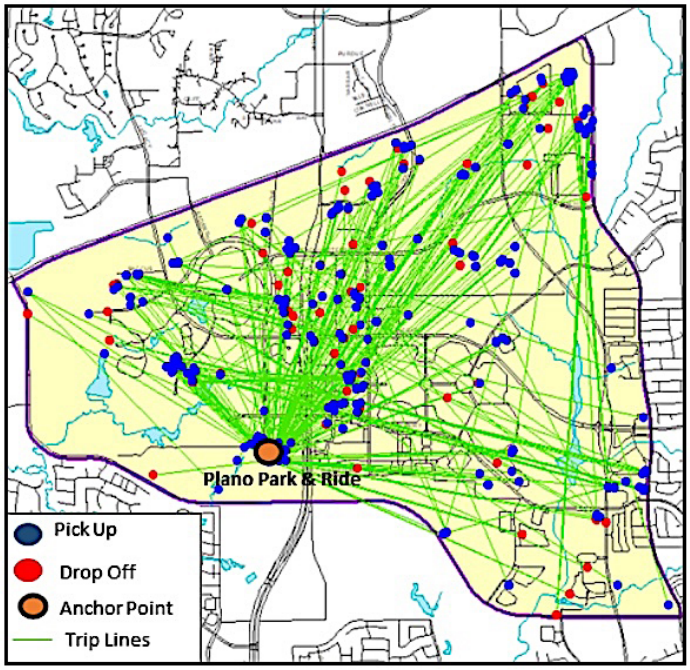


Figure 4-7

Anchor points in FNP zone

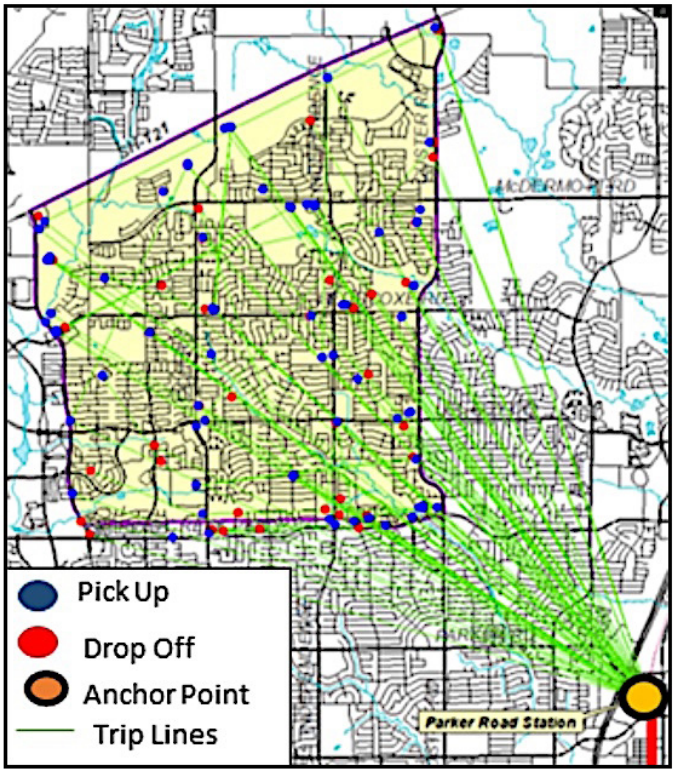
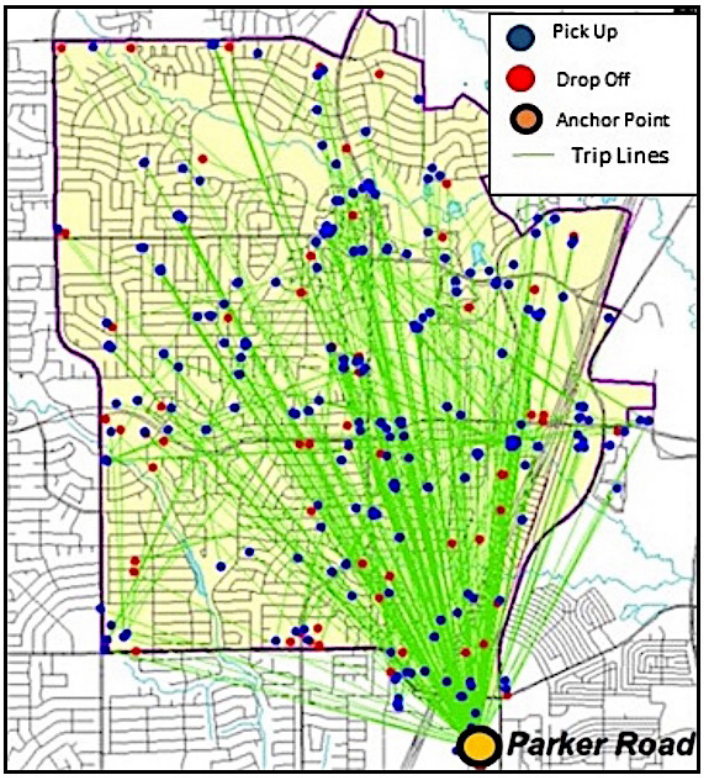


Figure 4-8

Anchor points in NCP zone



Activity data were used to compare the response time of all users to that of riders with disabilities. In April 2019, DART recorded 108 requests for riders with a wheelchair, cane, or scooter who booked a trip. DART GoLink provided service with a response time of 6 minutes in Legacy West and 7 minutes in NCP; no FNP trip requests for riders with disabilities were recorded. Comparing the service of riders with disabilities with the general public, it can be concluded that riders with disabilities had a better response time than Plano users.

Table 4-8

GoLink Average Response Time for Riders with Disabilities, All Plano Zones, April 2019

Zone	Average Response Time
Legacy West	6 min
NCP	7 min
FNP	No record

Adding UberPool to back up MOD GoLink service impacted response time in a positive way. Whereas GoLink recorded an average response time of 10 minutes,[3] UberPool provided the service with an average wait time of 5 minutes[4] from March to April[5] 2019. This shows the importance of incorporating TNCs to support a more efficient system, especially for riders who need to transfer to other modes to continue their transit trips.

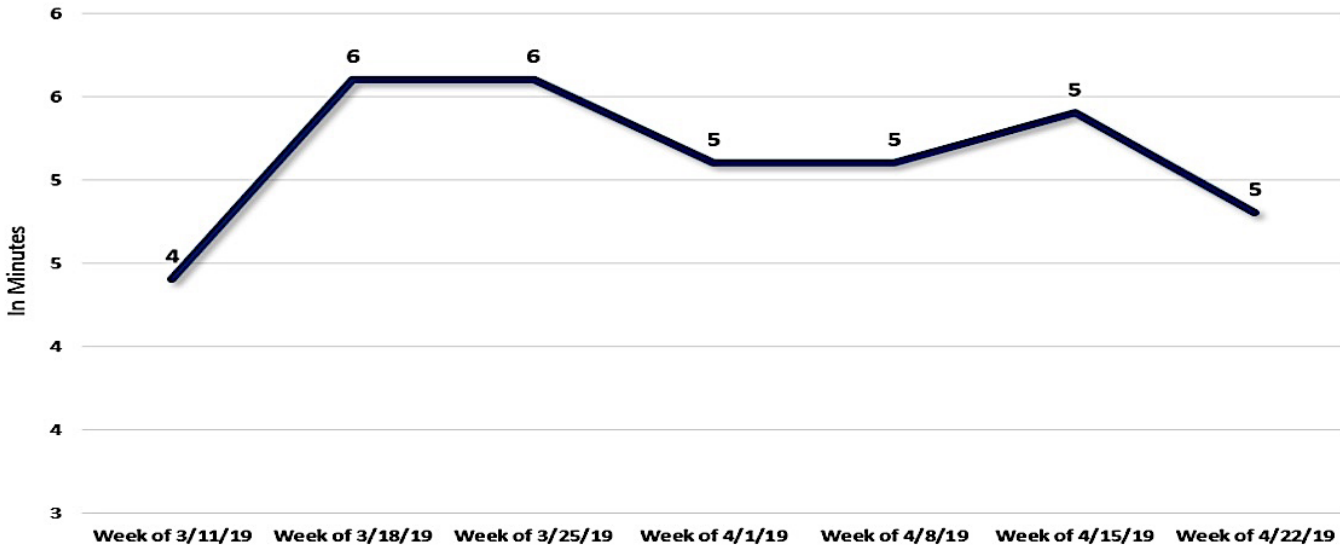


Figure 4-9

UberPool average response time for all Plano zones, March 11–April 22, 2019

DART also incorporated questions about approximate wait time to evaluate it based on user perceptions. Results show that more than 70% of riders rated their wait time as good or excellent; no riders with disabilities rated it very poor.

[3]10 minutes was the average response time from April 2018–March 2019 for all zones.
[4]5 minutes was the average response time from March 2019–April 2019 for all zones.
[5]After April, numbers are reported monthly.

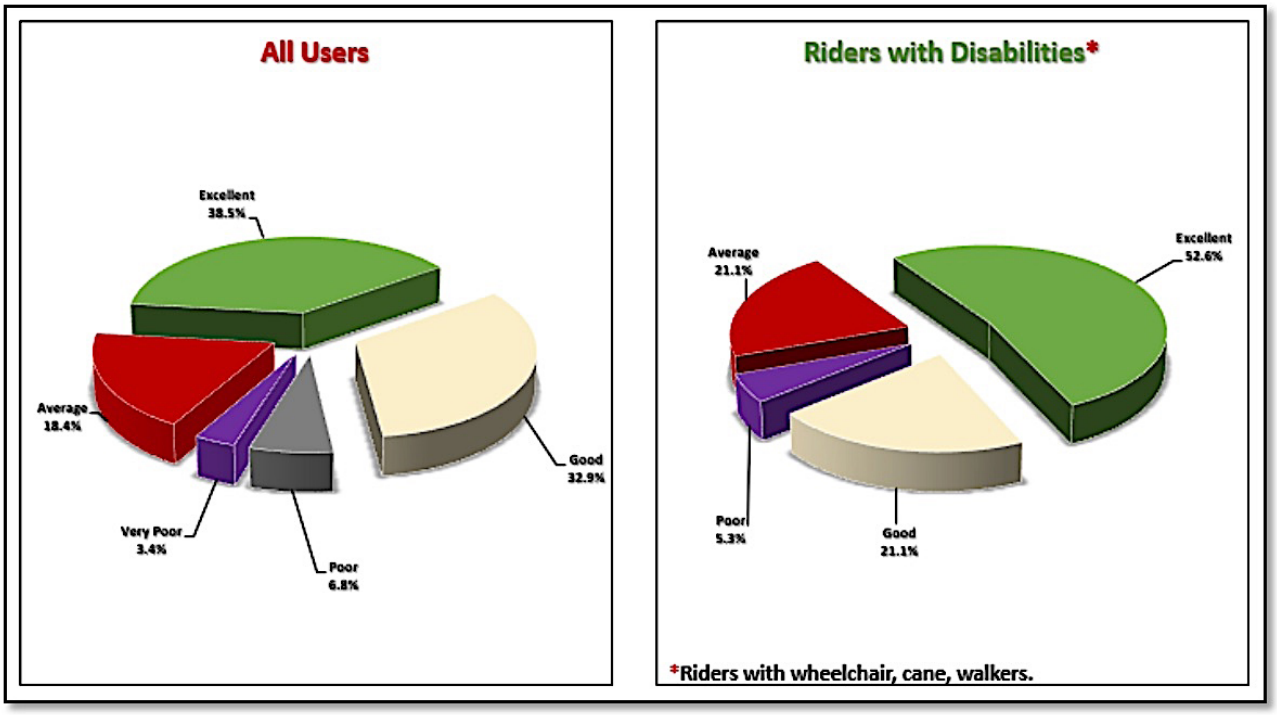


Figure 4-10

Ratings of GoLink response time in Plano zones by all users and riders with disabilities

Table 4-9

Ratings of GoLink Response Time in Plano Zones by All Users and Riders with Disabilities

Rating	All Users	Riders with Disabilities
Excellent	38.5%	52.6%
Good	32.9%	21.1%
Average	18.4%	21.1%
Poor	6.8%	5.3%
Very Poor	3.4%	0.0%

Travel Time

The DART project intended to provide a more efficient system by reducing transit travel time. The GoLink average travel time in Plano zones for April 2018–June 2019 was 13 minutes; Legacy West had the lowest average travel time, and FNP had the highest.

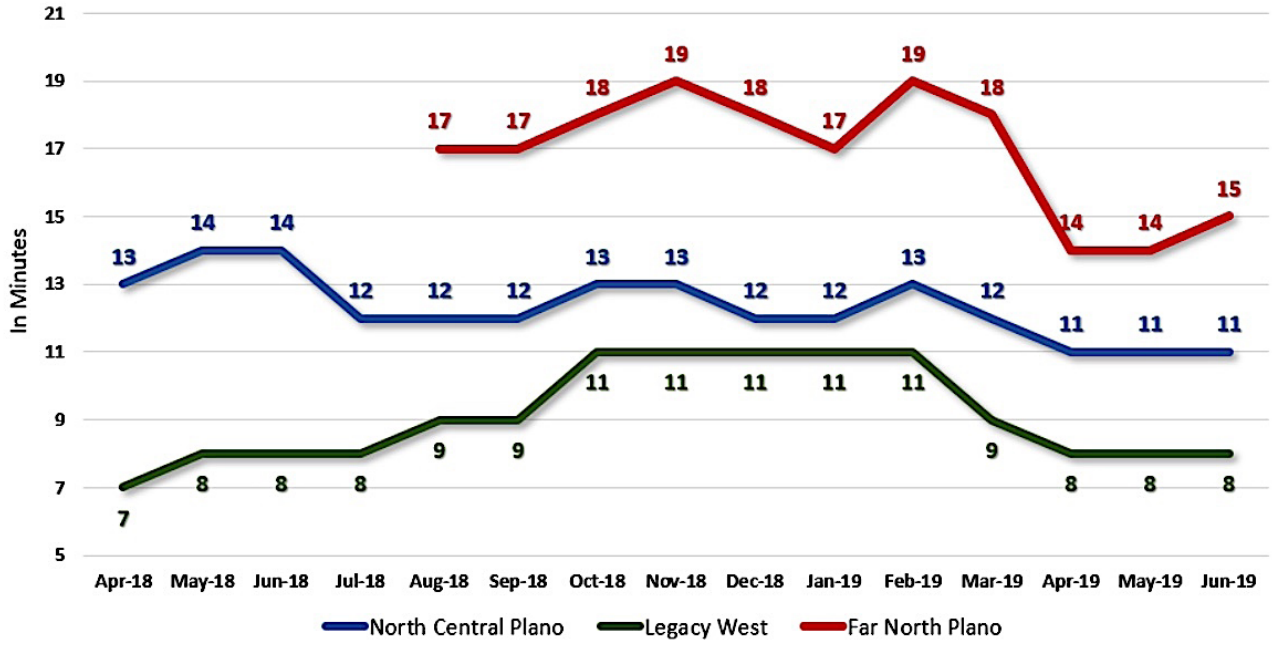


Figure 4-11

GoLink average travel time for all Plano zones, April 2018–June 2019

Table 4-10

GoLink Average Travel Time for App Users, April 2019

Zones	Average Travel Time
Legacy West	8 min
NCP	11 min
FNP	18 min

Based on April 2019 activity data, riders with mobility devices (wheelchair, scooters, etc.) had an average travel time of 11 minutes for both Legacy West and NCP; no trips for riders with mobility devices were recorded for FNP.

Although Plano GoLink had an average travel time of 12 minutes, the average travel time for UberPool users (March 2019–May 2019) was 8 minutes. A reason for the shorter travel time in UberPool is that GoLink usually must deviate to pick up other riders; UberPool is a shared-ride service, but many of its UberPool trips are for a single ride.

Figure 4-13 and Table 4-11 show the results of user satisfaction concerning travel time, with almost 80% of the users being satisfied.

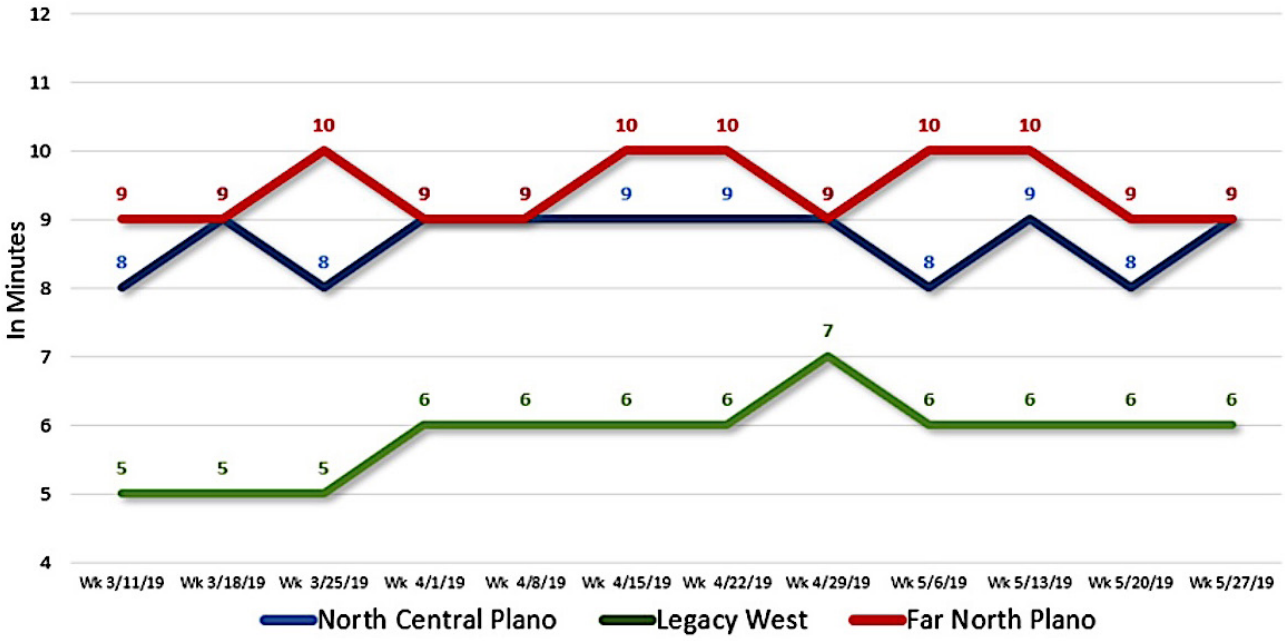


Figure 4-12

UberPool average travel time for all Plano zones, March 11–April 22, 2019

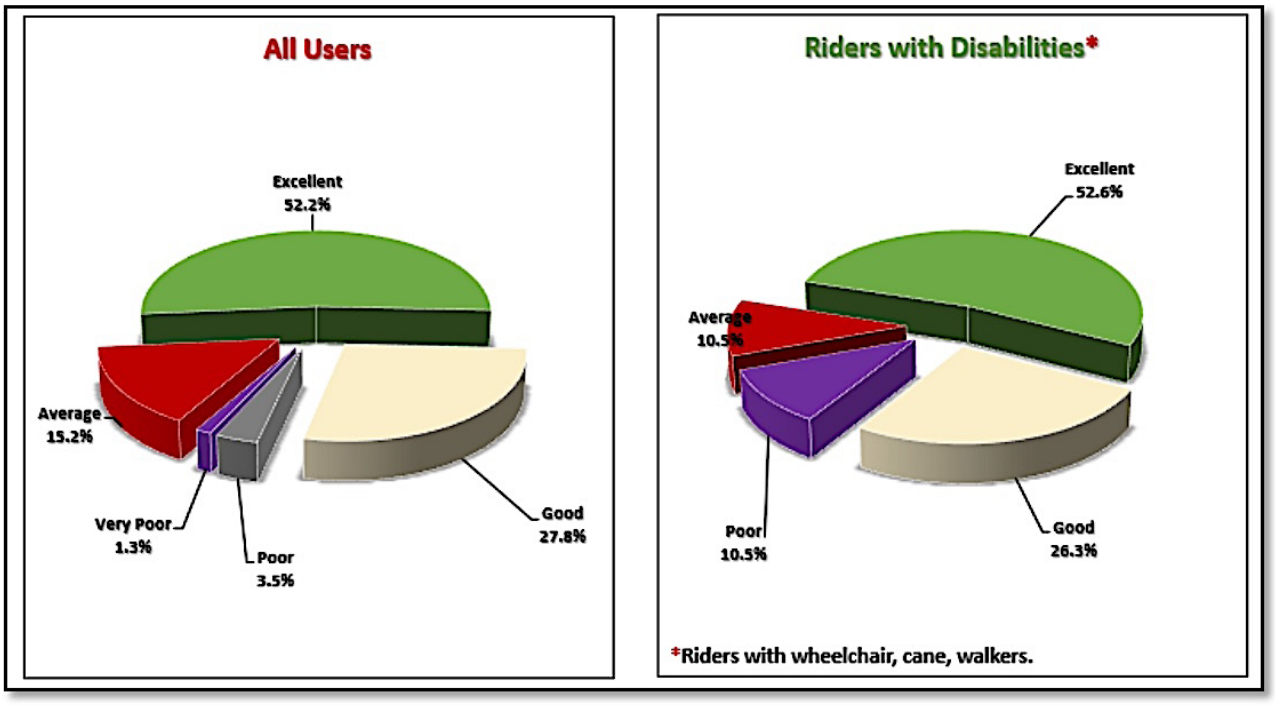


Figure 4-13

Ratings of GoLink travel time in Plano zones by all users and riders with disabilities

Table 4-11

Ratings of GoLink Travel Time in Plano Zones by All Users and Riders with Disabilities

Rate	All Users	Riders with Disabilities
Excellent	52.2%	52.6%
Good	27.8%	26.3%
Average	15.2%	10.5%
Poor	3.5%	10.5%
Very Poor	1.3%	0.0%

Fares

DART intends to provide more affordable service to public transit users. When riders pay for bus, train, or other services, they can transfer to the GoLink system at no extra charge. Generally, DART fare types are Day Pass, Single Pass, AM/PM Pass, Midday Pass, and Monthly Pass, and GoLink users benefit from a special UberPool fare arrangement. For any trips within the zone but not to the anchor points, the fare is $3.00. Trips to the anchor points are free, a promotional rate that is still in effect. After the promotion rate is discontinued, the fare will be $1.00.

Table 4-12

DART Fares

Fare (Pass) Type	Categories	Rate
Day Pass	Local	$6.00
	Regional	$12.00
	Reduced	$3.00
Single Ride	Local	$2.50
	Reduced	$1.25
AM/PM Pass	Local	$3.00
	Reduced	$1.50
Midday Pass	Local	$2.00
Monthly Pass	Local	$96.00
	Regional	$192.00
	Reduced	$48.00
UberPool	Promotion period (trips to Anchor Points)	$0.00
	After promotion period (trips to anchor points)	$1.00
	Trips not to anchor points	$3.00

Customer Satisfaction

DART has the goal to improve customer satisfaction through the implementation of the MOD Sandbox project. The DART GoPass app permits users to rate the system. Based on April 2019 data from 1,138 riders who rated the system, almost 91% gave it five stars.

Figure 4-14

Ratings of GoLink from app

To evaluate performance, DART also conducted onboard surveys that asked the users to rate their overall experience with DART GoLink, GoPass, and UberPool. The surveys also asked users if they would recommend GoLink Service to a family member or friend. Results show that almost 86% of all users and 89% of riders with disabilities rated the system as good or excellent

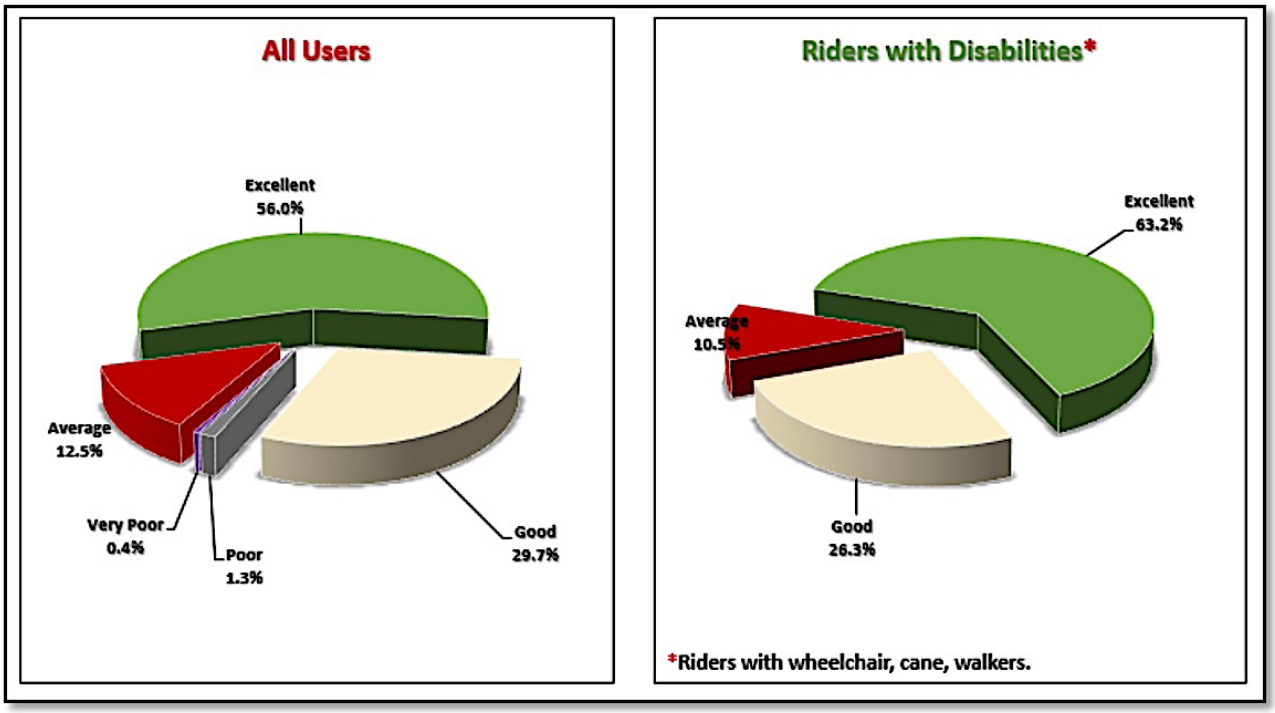


Figure 4-15

Ratings of overall experience with GoLink by all users and riders with disabilities

Table 4-13

Ratings of Overall Experience using GoLink for All Users and Riders with Disabilities

Rate	All Users	Riders with Disabilities
Excellent	56.0%	63.2%
Good	29.7%	26.3%
Average	12.5%	10.5%
Poor	1.3%	0.0%
Very Poor	0.4%	0.0%

GoLink users can book their trip through app, by calling the reservation line, or by walking to the vehicle (flag downs). Generally, 70% of Plano trips are booked through the app. The Legacy West zone has the largest group of app users. In the two other zones, most trips are booked through the app, although calling is also favored. Almost 42% of trips in the NCP zone are made via phone.

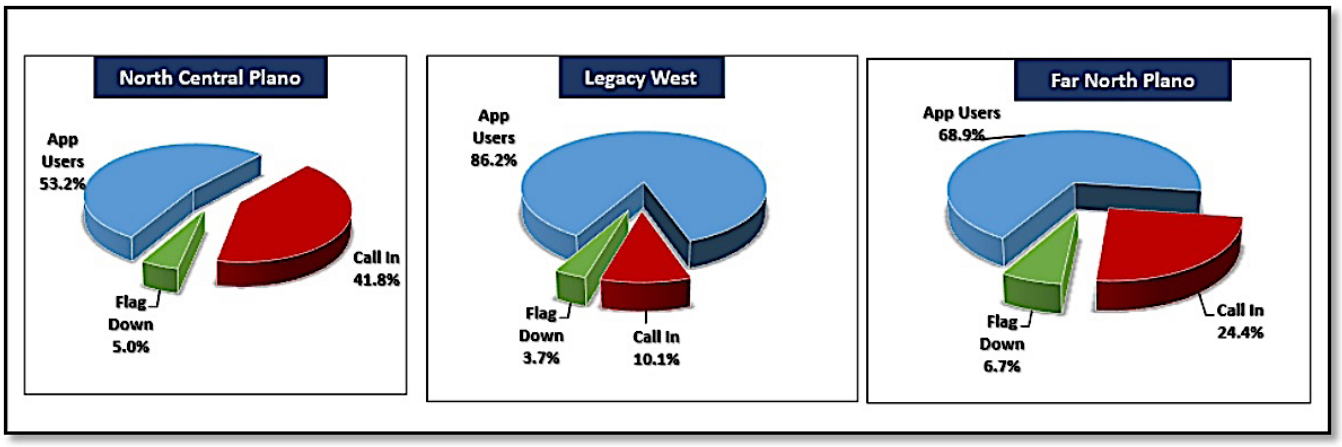


Figure 4-16

Plano booking system distribution

The GoPass app has several features including trip planning, scheduling, fare payment, and information as on events. To evaluate the experience of GoPass, the survey asked for ratings of features in the app. As Table 4-14 reveals, 82%, 80%, 83%, and 77% of all users rated trip planning, scheduling, fare payment, and other, respectively, as good or excellent. Table 4-15 shows that 78%, 67%, 94%, and 84% of riders with disabilities rated trip planning, scheduling, fare payment, and other, respectively, as good or excellent.

Table 4-14

Ratings of Overall Experience with GoPass Features by All Users

GoPass Features	Excellent	Good	Average	Poor	Very Poor
Trip planning	59%	23%	15%	2%	1%
Scheduling service	57%	23%	19%	2%	0%
Fare payment	61%	22%	15%	1%	0%
Other	52%	25%	15%	4%	5%

Table 4-15

Ratings of Overall Experience with GoPass Features by Riders with Disabilities

GoPass Features	Excellent	Good	Average	Poor	Very Poor
Trip planning	72%	6%	22%	0%	0%
Scheduling service	56%	11%	28%	6%	0%
Fare payment	75%	19%	6%	0%	0%
Other	67%	17%	0%	17%	0%

Survey results of all users show that 75% rated UberPool as good or excellent. The survey was conducted at the early stage of UberPool integration prior to widespread awareness of the UberPool option.

Table 4-16

Ratings of GoLink Service Since UberPool Joined DART to Provide Service

Rate	Percentage
Excellent	32%
Good	43%
Average	18%
Poor	4%
Very Poor	4%

In total, 88% of all riders surveyed and 95% of riders with disabilities surveyed responded that they would recommend GoLink Service to a family member or friend.

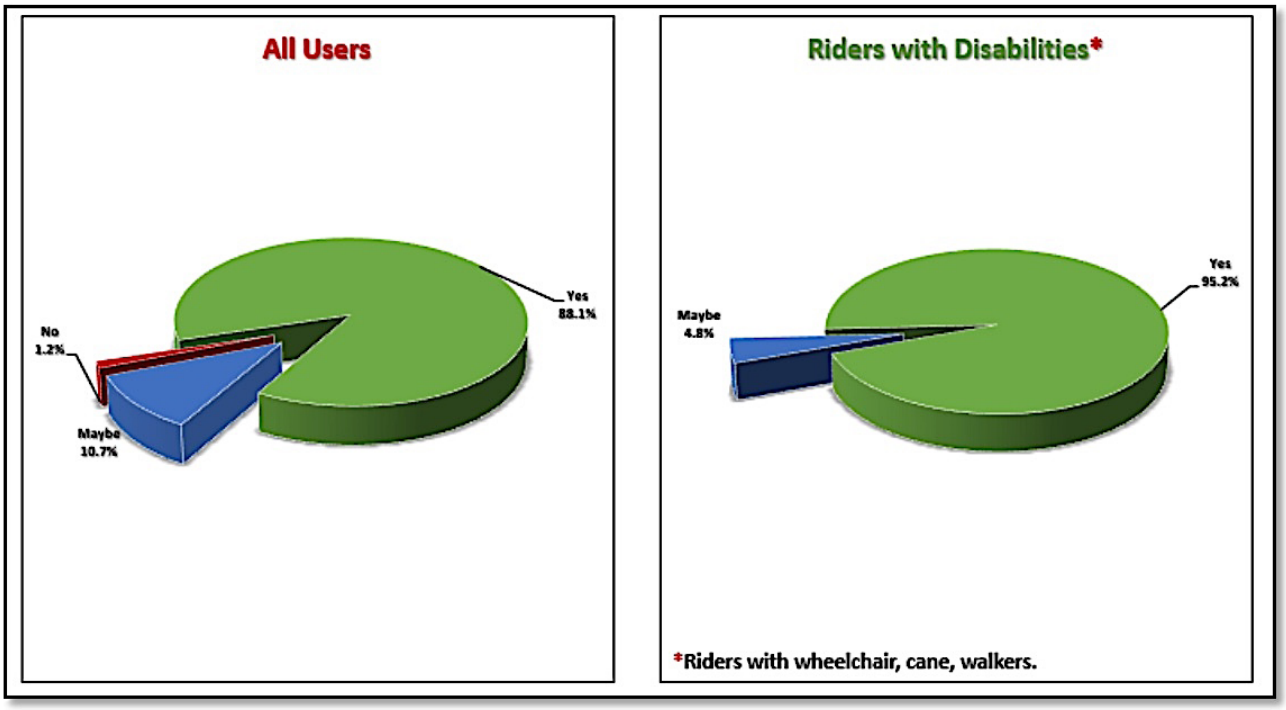


Figure 4-17

Ratings of "recommend GoLink service to family member or friend?" by all users and riders with disabilities

Transit Access Area

The DART MOD Sandbox project intended to expand service within certain areas, expand public transportation coverage, and improve access to jobs. The investment in public transit should focus on areas with less services.

Before March 2017, Plano had nine routes operated out of the North West Plano park-and-ride lot and Parker Road station, covering only 44% of the city's land area. After GoLink implementation, almost 82% of the city is now covered by both a GoLink zone and a fixed route.

Table 4-17

Plano Fixed-Route and GoLink Coverage Before and After GoLink Implementation

	Before (Acres)	After (Acres)
Bus route coverage	20,448	20,440
GoLink	0	17,306
Total	20,448	37,746

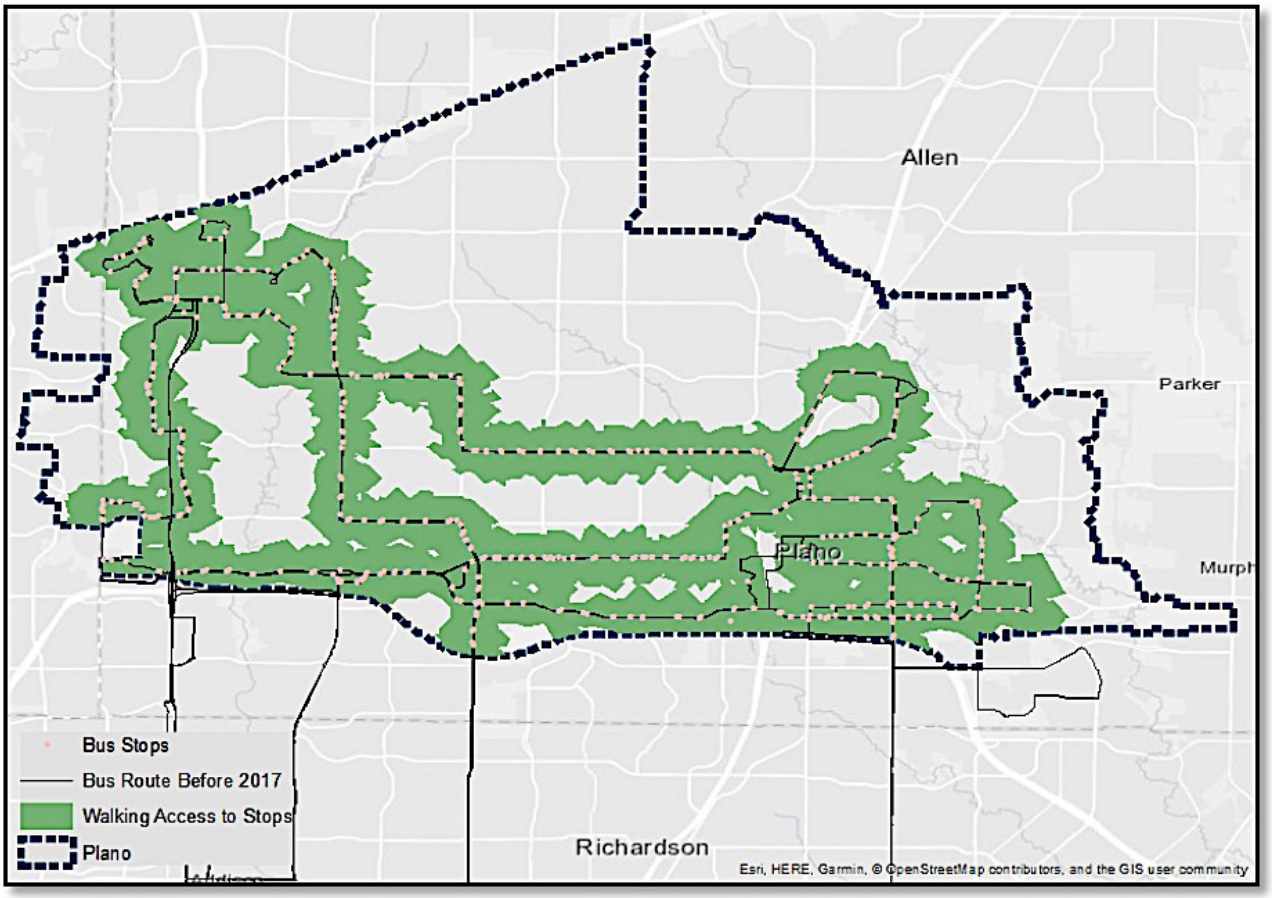


Figure 4-18

Plano fixed-route transit service area before March 2017

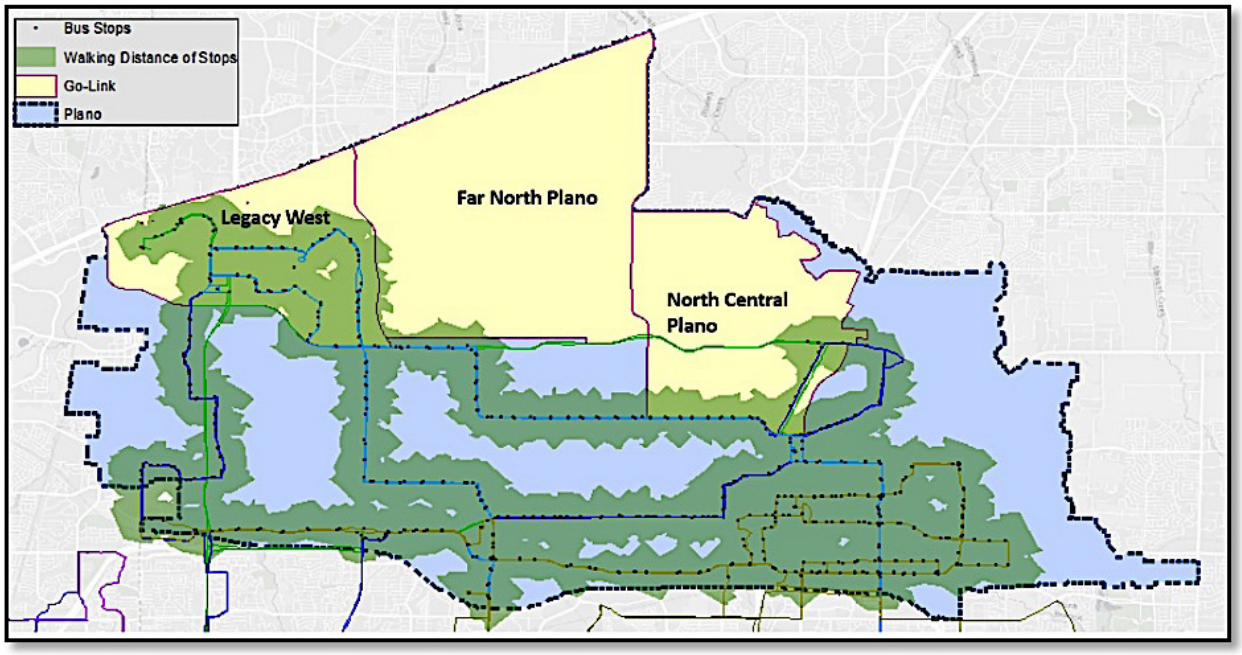


Figure 4-19

Plano service area covered by GoLink and fixed-route

Ridership Change

DART has the goal to improve ridership in the areas with few riders. Based on this, DART discontinued Route 346 in favor of GoLink in the Legacy West zone. Route 346 had weekday average ridership of 42 in FY18 for October–March, and in FY19, weekday average ridership for GoLink Legacy West for the same period was 131, an increase of 211%.

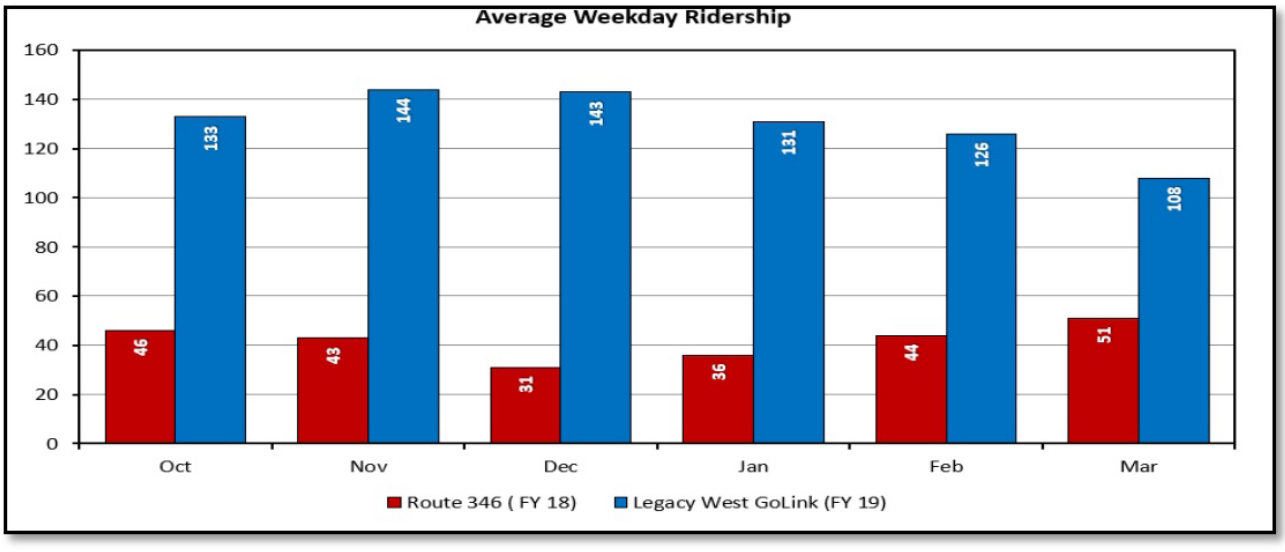


Figure 4-20

Average weekday ridership for Legacy West GoLink and Route 346, October 2018–March 2019

DART replaced NCP DOC with NCP GoLink service. In FY18, NCP DOC average weekday ridership was 71 for October–March; in FY19, NCP GoLink had an average weekday ridership of 118, a 66% increase in ridership. FNP GoLink was a new system and prior to that, there was no service in that area.

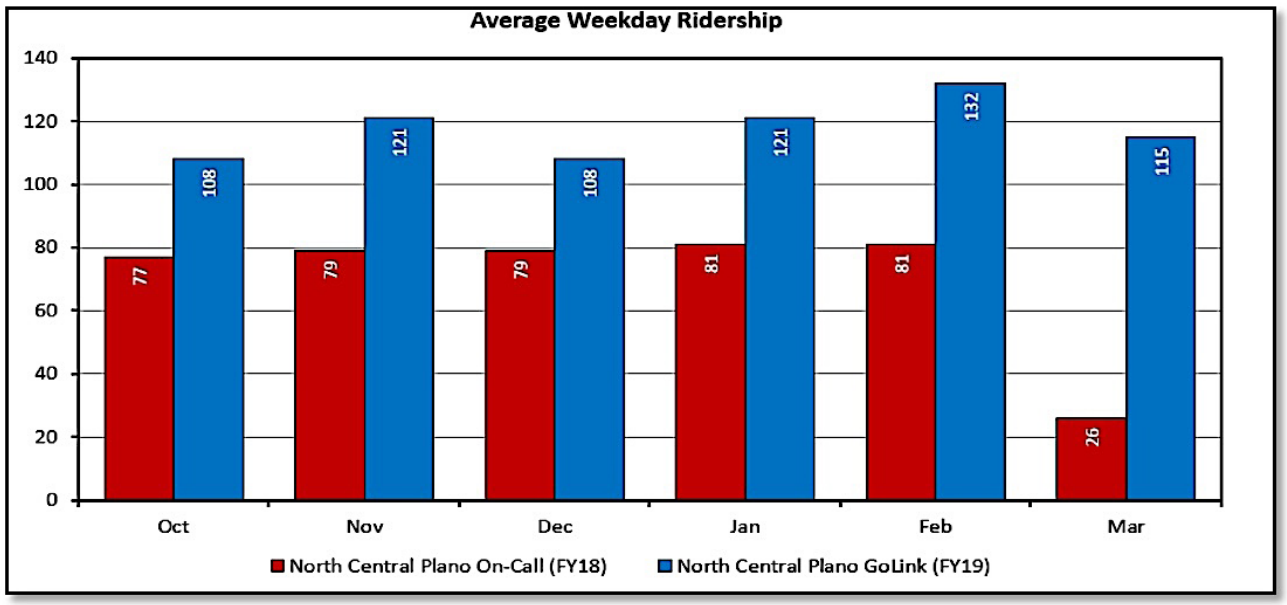


Figure 4-21

Average weekday ridership for NCP GoLink and NCP DOC, October 2018–March 2019

As evident from Figure 4-22, Legacy West had a higher ridership than the two other zones. However, NCP was not far behind. FNP had the lowest ridership of the three Plano zones.

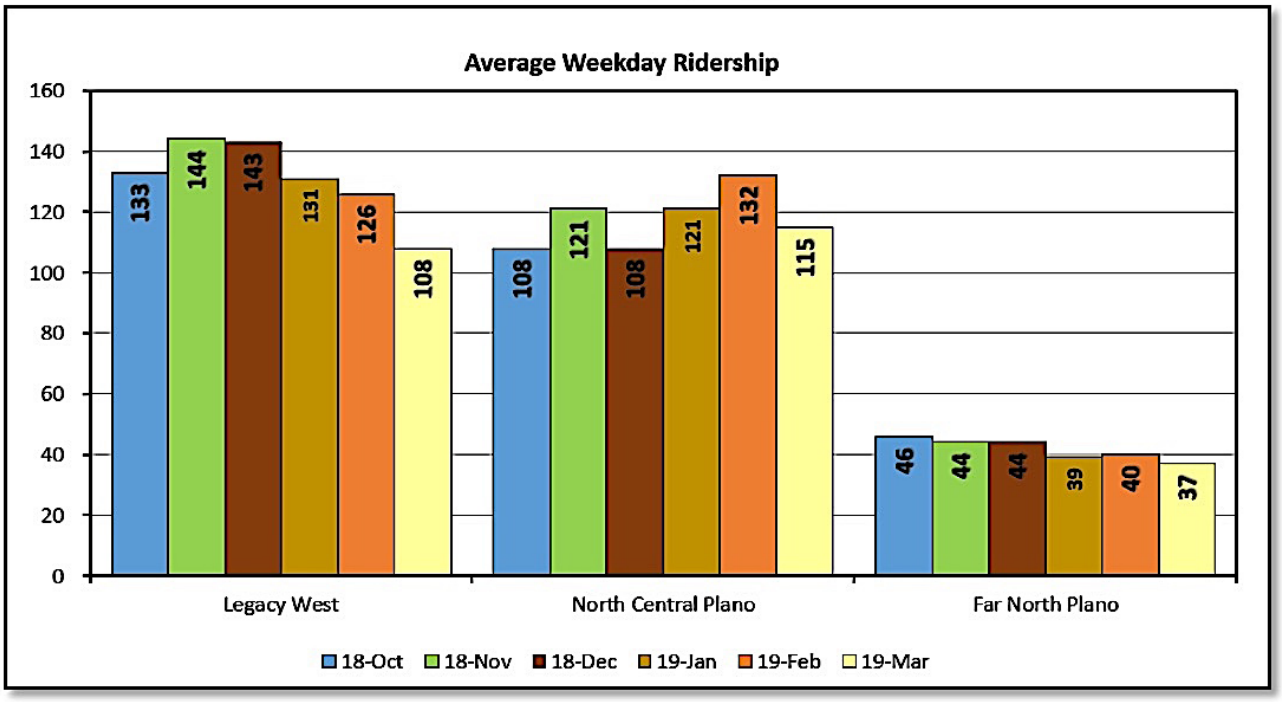


Figure 4-22

GoLink average weekday ridership before UberPool, all Plano zones, October 2018–February 2019

In March 2019, DART started the UberPool program in the Plano GoLink zones, which led to ridership increases. The average weekday ridership for October 2018–February 2019 (before UberPool) was 135, with Legacy West, 118 for NCP, and 43 for FNP. From March 2019 to May 2019, ridership increased by 5% in Legacy West, 23% in NCP, and 33% in NCP after UberPool was added.

Table 4-18

Average Weekday Ridership for GoLink and GoLink + UberPool, All Plano Zones

Zones	GoLink Average Weekday Ridership	GoLink and UberPool Average Weekday Ridership	Percentage Increase
Legacy West	135	142	5%
NCP	118	146	23%
FNP	43	57	33%

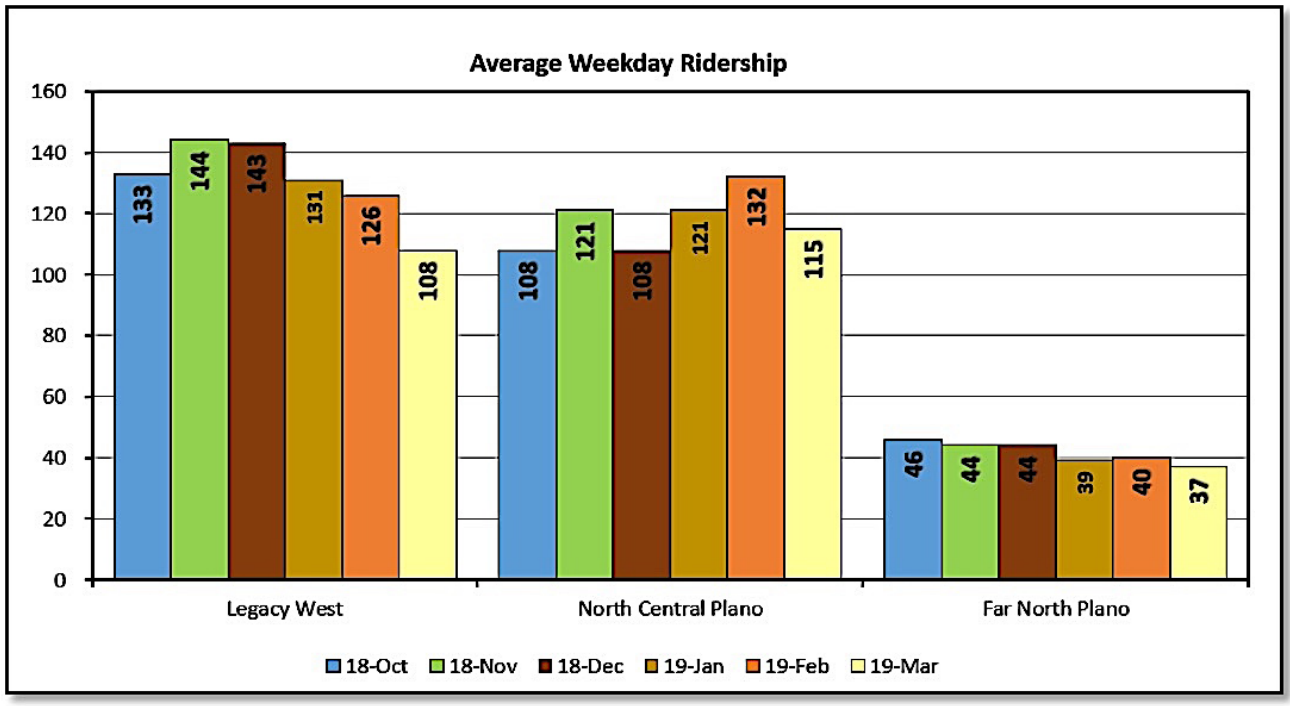


Figure 4-23

GoLink + UberPool ridership for all Plano zones, October 2018–May 2019

Subsidy Per Rider

DART has the goal to replace ineffective, costly fixed-route transit with MOD services. DART compared subsidy per rider for the replaced system with new GoLink and UberPool services. Note that before and after comparisons in zones and route travel sheds do not perfectly align with subsequent GoLink zones. From April 2018 to March 2019, an average subsidy per rider for the Plano zones was $16.37. As shown in Figure 4-24, NCP has the lowest subsidy per rider (average of $13.70), and FNP has the highest (average of $24.80).

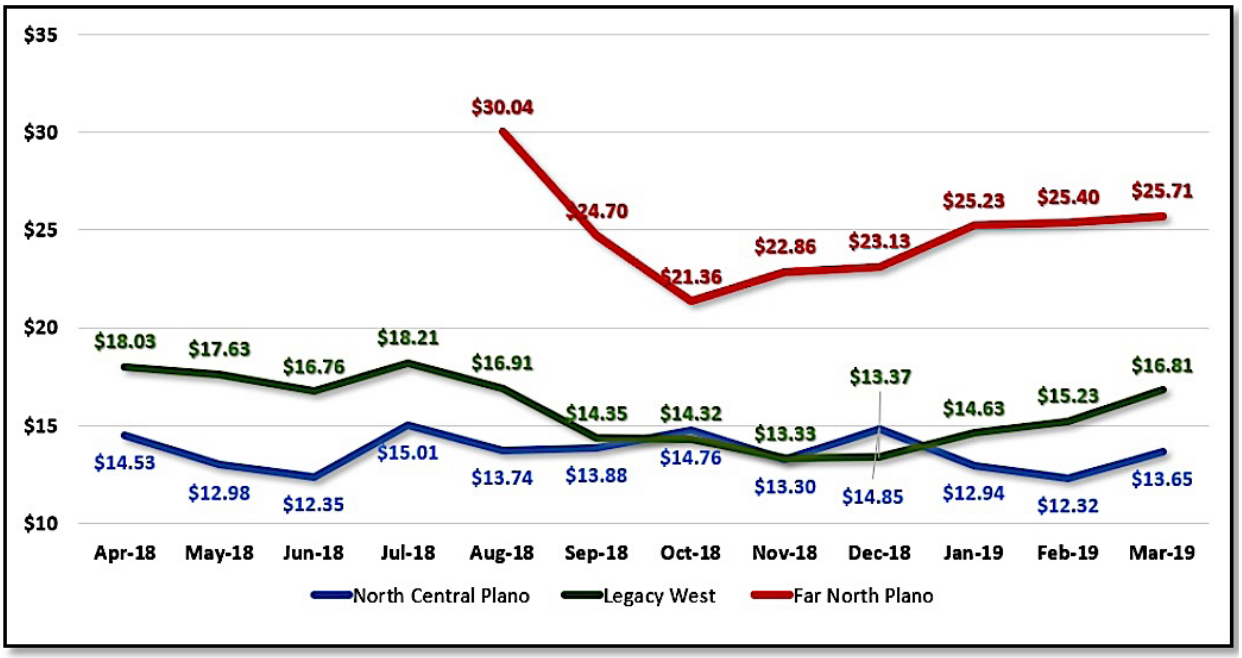


Figure 4-24

GoLink subsidy per rider for Plano zones

As noted, Legacy West zone replaced bus Route 346. In the first and second quarters of FY18, this route had an average subsidy per rider of $33.71; replacing it with GoLink reduced the cost by 53%. Also, NCP DOC, discontinued in favor of GoLink service, had an average subsidy per rider of $11.43 for the first two quarters of 2018. NCP GoLink had an average subsidy per rider of $13.70, which could be due to the increased coverage of NCP GoLink. FNP was a new system in the zone, with an average subsidy per rider of $24.80.

GoLink showed an average subsidy per rider of $16.37 for the Plano zones from April 2018 to March 2019, whereas UberPool had an average subsidy per rider of $5.00 from March 2019 to May 2019. This shows the impact of using TNCs as an option to supplement service and contain costs in GoLink zones.

UberPool ridership increased every month since it was added to GoLink microtransit. Productivity exceeded 7 passengers per revenue hour compared to 2.5 passengers per revenue hour for the GoLink service provided with dedicated vehicle.

Table 4-19

UberPool Performance, March–June 2019

Parameters	Mar 2019	Apr 2019	May 2019	June 2019
Revenue Hours	134	342	362	485
Passengers	1,043	2,561	2,712	3,721
Passengers Revenue Hour	7.8	7.5	7.5	7.7
Subsidy per Passenger	$5.16	$4.87	$4.85	$4.97
Trips	983	2,469	2,634	3,502
Trips per Revenue Hour	7.3	7.2	7.3	7.2
Subsidy per Trip	$5.47	$5.05	$4.99	$5.22

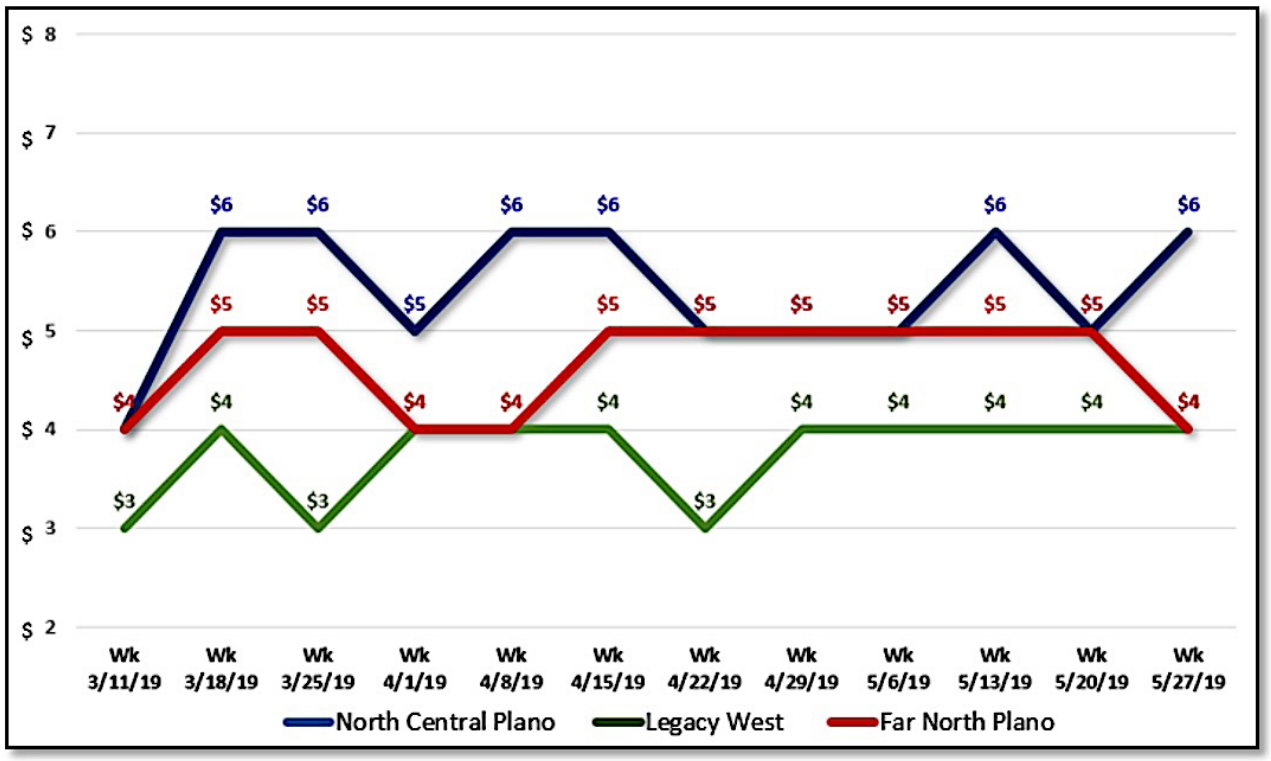


Figure 4-25

UberPool subsidy per rider, all Plano zones

Operating Costs

DART aims to provide quality transit service with less cost through implementation of GoLink. Table 4-20 shows the gross and net costs of operating GoLink and UberPool service service from its inception in November 2017 to May 2019. During this period, Route 346 and North Central Plano On-Call were discontinued, but their costs were projected through the period.

Table 4-20

Cost Comparison of Plano Service, November 2017–May 2019

Categories	Cost
Total Plano GoLink and Uber Plano Gross cost	$1,479,505
DOC and Route 346 Projected Through Period	$619,237
Net Plano GoLink and Uber cost	$860,268

During November 2017–May 2019, DART spent or was projected to spend $619,237 to operate Route 346 and the NCP DOC. These did not adequately serve Legacy West and provided no service to the FNP zone or to the Chase Oaks neighborhood.

During this same period, Plano GoLink operations and the short three-month period of Uber operation cost $1,479,505, including new service to Legacy West and FNP as well as new GoLink Service to NCP extended to cover all of Chase Oaks. Netting out the service cost of Route 346 NCP DOC, it cost DART an additional $860,268 to provide GoLink and UberPool service to Legacy West, FNP, and NCP, including the new Chase Oaks extension. This additional cost provided GoLink and UberPool service to all of Plano and more effective, desirable service to areas already served. In addition, the survey trends discussed above indicate that GoLink and UberPool services have market growth potential, which the prior service did not exhibit. Although GoLink is costly, as ridership grows, and with some trips shifting to UberPool, costs per rider will decrease, and additional riders will be attracted by the improved service.

SECTION

5

Conclusion, Lessons Learned, and Next Steps

DART started the MOD Sandbox project to improve transportation efficiency by providing a more accessible service that integrates technology and innovative partnerships, increases transportation effectiveness, offers service to all riders, and enhances the customer experience. DART's MOD service was a unique pilot project that can be used to set up comparable projects at other transit agencies. The service resulted from efforts by FTA to provide seed money for Mobility on Demand while allowing some flexibility in regular procurement processes when required by the timeline of the pilot project. In addition, the North Central Texas Council of Government facilitated and expedited the MOD project, providing a regional forum on MOD that met periodically. Local agencies such as the City of Plano, Plano private and non-profits corporations, and the Legacy Connect Transportation Management Association provided vital grassroots marketing and awareness of the project.

In general, the system achieved most of its goals by increasing ridership, achieving a lower cost per passenger and more efficient travel and wait times while expanding the area served by transit, and improving the customer satisfaction of general users and riders with disabilities. However, the project faced some challenges and produced some lessons learned for DART and other transit agencies.

First, the use of the technology demanded a change in the transit environment and a strong backup support system to continue operation. The technology change required a change in rider perspectives, which required patience and time. Moreover, designing tailored service to specific geographical zones involved intensive marketing campaigns with designated costs and incentives.

Second, integrating with other travel options such as GoPool and TNCs was a new experience. For carpools, a big challenge was competing with existing competitors that did not have policy limitations like DART (such as location of service delivery and background check prerequisites), which created imbalances of riders and drivers. Although this was the case for carpooling system, DART's experience with TNCs was successful, with issues such as policy agreement for data-sharing and service policy agreements such as payment and technology changes for TNC partnership with DART.

Lessons Learned

Operation and Technology Planning and Deployment

As noted, it is easier if operational personnel are in the loop when MOD software is chosen for the agency. Driver opinions of the app portion of the software are key to operational success. The devices and other hardware chosen for the driver app must be up to the task of MOD service and suitable for the environment in which they are operating (vibration, heat, humidity, direct sunlight, etc.).

It was important to check the voltage needed to keep the driver devices charged during revenue service, to invest in good device chargers, and to make sure the vehicles can keep the devices charged during service hours. A Standard Operation Procedure (SOP) was developed to replace devices that failed in the field during revenue service. DART purchased charged spare driver devices to support multiple in-field failures at the same time. Personnel were on hand to troubleshoot devices during all days and hours of operation.

When drivers reported that trip sequences were inefficient due to technology limitations, DART passed this on to the MOD software provider. Also, in response, DART made ride-along trips mandatory for reservationists and dispatchers to allow them to experience what drivers faced with both technology and rider issues.

Rigorous end-to-end testing was needed to find bugs in technology and to identify rider issues and potential vehicle issues. When found, issues were reported to the developer for correction and enhancement. Multiple DART staff and operations and customer volunteers were recruited to assist with the testing. Support of other departments during planning, conception, testing, and project execution were vital to DART's MOD project and its growth.

As noted, it is important that staff responsible for implementing the technology be included in the choice of MOD software, as this is a large part of MOD's operational success. For a variety of reasons, especially time constraints, DART operations staff were able to adapt to technology changes only with considerable effort. Software reliability is crucial to the success of MOD service, but this alone is not enough. Software also needs to be driver-, reservations-, and dispatch-friendly, with a reporting function that is automated and efficient. If time permits, operations personnel should be given a demonstration of any proposed software before it is selected.

Another aspect of MOD software is reporting functions, which can assist with complaint resolution and driver location as well as scheduling, routing, and dispatching. Drivers recognized that trip sequences were not efficiently routed, and DART took the action to resolve these inefficiencies to improve trip scheduling for several zones.

DART allowed pre-scheduled trips and walk-on riders. The software had been designed for optimization of on-demand trips, so pre-scheduled and walk-on trips reduced the overall efficiency of the software. Drivers had to enter the information about riders who walked on to the vehicle in real time, which took time and led to delayed arrival at the next pickup/drop off location.

Related to operational updates, reservations and dispatch staff were trained in their respective areas of the MOD software over the span of a week for each new GoLink zone. DART and trained contractor personnel were on hand in the reservations and dispatch areas and the driver ready room for pullout on the morning of each zone's implementation to answer questions and assist with issues that arose. With the integration of GoLink into GoPass, retraining was provided to all operating personnel. Formal classes were held for both the AM and PM shift drivers, and a technology provider called in to each class and guided drivers through the changes. Drivers were able to view each change in the process via a web-cam presentation, and physical tablets were available if drivers wanted to practice working with the changes. DART and contractor staff were also available daily for drivers who missed formal classes, needed follow-up instruction, or had questions that came up in the field.

Marketing Planning and Execution

The Plano GoLink marketing effort ultimately proved effective to address challenges and further opportunities by providing one-on-one communication and emphasizing "feet on the street," which was critical and helped riders trust both the technology and the service. The project used simple marketing materials that did not overwhelm riders, which worked well because they carried the main message effectively and had a clear call to action for the audience.

The DART sub-branded GoLink vehicle design was useful in two ways. First, riders could clearly identify the service when it was approaching various locations, and second, the vehicles acted as advertising media, promoting the service while they traveled around Plano.

GoLink provided an opportunity for DART to use its excellent relationship with the service area cities' designated city communicators, who helped amplify DART's message through their multiple local lines of communication. Also, the project needed employer outreach, and marketing activities with area employers detailed earlier helped establish a good base of pilot participants. Finally, DART regularly monitored transactions in the GoLink zones and adjusted methods to achieve a better result, a critically important step.

The GoLink project also required phone reservation training. Marketing took care to monitor the complete customer service experience, including this critical interface with the phone reservations function by developing scripts

for call center personnel and an Interactive Voice Response (IVR) messaging system.

Although there many are success stories, DART faced some challenges. As noted, upgraded technology and a new approach to mobility can be confusing and disorienting to riders, increasing their natural resistance to change. Moreover, explaining something new and different to riders requires patience and a "retail" approach to generating acceptance. Although higher-tech transportation options ultimately improved service, they required patience and time. Many riders resisted the app and continued to use the call center. Over time, and with many app improvements, DART experienced regular growth in the percentage of app usage.

It is much more cost-effective to market to a larger geographical zone than the typical GoLink zone. Keeping the message targeted to such a small area made the marketing much more challenging, requiring DART to employ a grassroots, staff-intensive campaign. Moreover, neighborhoods have unique rider makeups; DART identified each zone's unique attributes and built a marketing campaign tailored to each area, which required resources intentionally budgeted to cover this marketing reality. A GoLink start-up in which marketers are unprepared and unbudgeted for this marketing reality is unlikely to meet its ridership goals.

Finally, obtaining the required number of intercept surveys to conduct meaningful research and assess system performance was a challenge for which DART had to offer incentives, such as a chance to win a monthly pass. DART eventually achieved the target number of recruits by offering incentives and shifting its recruitment efforts to be more expansive.

GoPool Integration

The main issues contributing to GoPool's lack of success were not technical. Like GoLink, the GoPool app functioned very well within GoPass, but there was a severe imbalance of drivers to riders entering the app database. For the database to automatically match riders with drivers in the pilot locations, drivers seeking riders, and riders seeking a ride needed to be roughly in balance. For much of the pilot, the number of drivers never exceeded 6, but the number of riders seeking drivers exceeded 100.

The lack of drivers can also be attributed to the difficulty of the background check process. As a prerequisite, DART required drivers to complete a background check to verify that they did not have any outstanding tickets or criminal convictions. This required many verification steps for drivers to complete, and it was time-consuming for DART to remind drivers to keep powering through the process. As noted, in the end, only six drivers made it through the entire background check.

Liability was another issue affecting the project's success. Because most employers in the service area wanted a straightforward project in which neither they nor their commuters assumed liability, many were hesitant to sign on and promote GoPool internally.

Finally, given that most of the area outside the DART service area is low-density, there was a reduced chance of two complementary driver-carpool pairs traveling to the same pilot area. It was not only difficult to develop matched pairs at the origin point, but also the density to allow commuters to walk or drive conveniently between employers was missing. Effectively, carpoolers had to work for the same employer.

Also, since the project was brand new, it lacked the critical mass for carpooling success compared to existing carpool software/applications, such as Waze, a competitor that matches from a large and well-established commuter base. Outside Plano, the Amazon Fulfillment Center, located south of Dallas, is an example of an employer that signed on with Waze Carpool rather than GoPool based on another employer's success with Waze. Streamlining their carpooling services with Waze made more sense to Amazon than signing with GoPool, despite their currently-contracted GoLink weekend service, which transports commuters to Amazon from the UNT Dallas Station. However, even with promotion within the businesses and with regional partners, a critical mass of commuters was not achieved in Plano or the other pilot area that was not a part of the MOD Sandbox Demonstration.

In conclusion, as an alternative to the GoPool project, DART plans to collaborate with the North Central Texas Council of Governments on a revamp of its regional ride-matching site, TryParkingIt.com, which reportedly will include dynamic carpool options not available in prior versions. With this new site, there will be an opportunity to implement a carpooling component with a vendor such as Scoop, Waze Carpool, or Carma. With integration into GoPass of a larger ridesharing database, DART expects to increase mobility options for commuters inside and outside the DART service area, linking riders and employers via carpool to complement existing vanpool, buses, light rail and commuter rail.

UberPool Non-Dedicated Microtransit

The experience with UberPool has generally been positive. There are several areas in which DART did not fully realize its plan for UberPool. First, DART had hoped to schedule trips with UberPool without the need for customers to have the Uber app, which would have permitted close integration within the GoPass app and would have resulted in a larger percentage of trips being operated by Uber. Several reasons that this was not possible for several reasons; the primary reason is that the API DART had hoped to use was designed only for UberX, not UberPool.

Second, Uber viewed GoLink customers as Uber customers and strove to protect their confidentiality; DART viewed them as GoLink customers and Uber as an efficient service provider. These two different perceptions will be issues for any transit agency using TNCs and could undermine a successful partnership. In this case, Uber was highly-motivated to move into the transit market, and DART to minimize costs. Careful and extensive negotiations with Uber provided a way to track passenger activity without revealing Uber's customer database.

Third, Uber has invested significantly to provide safety and security to its driver partners and its customers. Without the Uber app, Uber was not sure how to meet its safety and security standards. Research on this subject continues.

Finally, there are financial issues that Uber controls through the payment system on its app, such as late cancellation charges, customer damage, and cleaning fees, that needed to be negotiated with DART. These discussions continue as the partnership flourishes.

Next Steps

This report provides some policy recommendations to improve the performance of the DART's MOD system. First, Federal, regional, and local government awareness and support are a major requirement for the success of MOD. The collaboration of local decisionmakers and staff is especially crucial to service in MOD zones, as they have numerous channels of citizen contact to increase the visibility and awareness of the service and attract more riders to the system. Transit agencies in the region need to further collaborate to enhance regional programs, including carpooling to reach more riders and updating software and technology to provide same-day carpool matching.

Second, the use of technology demands changes in transit perspectives on provision of service delivery and the application of new methods to support the system. It is recommended that transit agencies create incentives to encourage the use of the technology. DART developed fare discounts that are applicable to new app users, which encouraged riders to use the technology and decreased dispatch costs. By contrast, it is also important to understand the limitations of technology and the barriers it presents for the system and users. It is recommended that transit agencies develop a support system to facilitate a smooth transition and change in behavior. For example, smartphone apps and mobile ticketing create barriers for disadvantaged riders who do not have internet access or a credit card. Transit agencies should provide multiple options and methods for users without neglecting rider status (Transit Technology White Paper, 2017).

Third, the DART MOD Sandbox GoLink and GoPool services required internal collaboration from the beginning of the project, not only among all executive-level decisionmakers but among all staff expected to carry out technical, operational, and marketing aspects of MOD. DART's pilot project involved a weekly meeting over a period of two years for all these players to plan the MOD zones, assign the resources and budgets, train the drivers and all related staff, expand and change GoLink zones within the app, and evaluate performance from the marketing, planning, finance, technology, and operations perspectives.

The TNC service filled transportation network gaps and introduced a more convenient travel option (Moran, 2016). Integration of multiple microtransit and TNC services are critical for both agencies and customers, as it can supplement the existing transit service with faster trip times and at less cost. TNC use is recommended to extend transit coverage for late nights and weekends when regular transit service cannot be provided economically. With the expansion of GoLink service to new zones and its substitution for former DART On-Call, the presence of accessible vehicles has also expanded.

ACRONYMS AND ABBREVIATIONS

MOD	Mobility on Demand
DART	Dallas Area Rapid Transit
FTA	Federal Transit Administration
TNC	Transportation Network Company
DOC	DART On-Call
FHWA	Federal Highway Administration
FNP	Far North Plano
NCP	North Central Plano
app	Application
SOP	Standard Operation Procedure
UX	User Experience
CI	Customer Interface
SUV	Single-Occupancy Vehicle
DFW	Dallas - Fort Worth
FMLM	First Mile/Last Mile
ADA	American with Disabilities Act
WAV	Wheelchair Access Vehicles
API	Application Program Interface

GLOSSARY

Anchor point is defined as a designated DART park lot facility associated with a given zone.

Carpooling is the system that facilitates trips between two commuters with a similar route. In this system, the passenger pays the share of the fare to the driver.

GoLink is a personalized, on-demand, curb-to-curb service when and where the passenger needs it within a specific zone (DART, 2019).

Mobility on Demand Sandbox Demonstration is an FTA project designed to support transit agencies to innovate, develop partnerships, create new business models, and integrate new technologies for in transit system for payment, decision support, and create incentives for the choice of travelers (FTA, 2019)

Paratransit is an origin to destination, curb-to-curb, service designed for people with disabilities who are unable to use fixed route buses or trains

Vanpool is a service for 6-15 people to a workplace from an area not served by DART rail or bus. Riders are guaranteed a seat and share the cost of the van amongst the passengers (DART, 2019).

REFERENCES

DART (2019). https://www.dart.org/.

FTA (2019). Mobility on Demand (MOD) Sandbox Program: https://www.transit.dot.gov/research-innovation/mobility-demand-mod-sandbox-program.

Gomez-Ibañez, Jose A. and Parks, Robert B. (2017). DART On-Call: Mobility on Demand in the Suburbs.

Moazzeni, S. (2018). Access to Opportunity and the Impacts on Housing Value (Doctoral dissertation).

Moran, M. (2016). "Policy Implications of Transportation Network Companies."

U.S. Census Bureau (2016). "American Fact Finder – Results." factfinder.census.gov.

Weinreich, D., Hamidi, S., Bonakdar, A., Sardari, R., & Moazzeni, S. (2019). Serving the Riders that Need It: Understanding the Causes of Service Inequity in Multijurisdictional Transit Agencies (No. 19-03507).

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