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Mobility on Demand (MOD) Sandbox Demonstration: Regional Transportation Authority (RTA) of Pima County Adaptive Mobility with Reliability and Efficiency (AMORE)

Evaluation Report

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U.S. Department of Transportation
Federal Transit Administration

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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	liters	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)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC

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14. ABSTRACT
This report presents the results of an independent evaluation of the Regional Transportation Authority (RTA) of Pima County Adaptive Mobility with Reliability and Efficiency (AMORE) Mobility on Demand (MOD) Sandbox Demonstration implemented in the Tucson metropolitan area. The project is one of 11 MOD Sandbox Demonstrations sponsored by the Federal Transit Administration (FTA). The AMORE project consisted of collaboration between RTA, Metropia, and RubyRide to transform the existing fixed-route transit system, improve overall system reliability and efficiency, and increase ridership while delivering a seamless user experience. The evaluation involved exploring several hypotheses surrounding the project's impact on travel behavior, user experiences, and costs. The AMORE pilot, operated from October 2018 to May 2019, augmented the Rita Ranch neighborhood's transit-only service in Tucson with an integrated multimodal, community circulation-based mobility service that could be accessed, paid for, and managed through a single platform. Key strategies were to establish a financially-sustainable mobility ecosystem; introduce a subscription-based transit-hailing service (RubyRide) as a viable and affordable option for commuting or first-/last-mile service for public transit operations; achieve higher usage and occupancy; and seamlessly integrate community-based, social carpooling. Activity data were used to evaluate system performance in terms of vehicle miles traveled (VMT), cost, and automobile use. It was found that VMT was not reduced by the project, and the system was not cost-competitive with existing demand-response services, at least as implemented within the research and development context; nevertheless, it served as a new affordable travel mode for users in the region. These and other findings suggest that although the project was well-intentioned, regions of deployment need to be considered for suitability with the project design.

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Abstract

This report presents the results of an independent evaluation of the Regional Transportation Authority (RTA) of Pima County Adaptive Mobility with Reliability and Efficiency (AMORE) Mobility on Demand (MOD) Sandbox Demonstration implemented in the Tucson metropolitan area. The project is one of 11 MOD Sandbox Demonstrations sponsored by the Federal Transit Administration (FTA). The AMORE project consisted of collaboration between RTA, Metropia, and RubyRide to transform the existing fixed-route transit system, improve overall system reliability and efficiency, and increase ridership while delivering a seamless user experience. The evaluation involved exploring several hypotheses surrounding the project's impact on travel behavior, user experiences, and costs. The AMORE pilot, operated from October 2018 to May 2019, augmented the Rita Ranch neighborhood's transit-only service in Tucson with an integrated multimodal, community circulation-based mobility service that could be accessed, paid for, and managed through a single platform. Key strategies were to establish a financially-sustainable mobility ecosystem; introduce a subscription-based transit-hailing service (RubyRide) as a viable and affordable option for commuting or first-/last-mile service for public transit operations; achieve higher usage and occupancy; and seamlessly integrate community-based, social carpooling. Activity data were used to evaluate system performance in terms of vehicle miles traveled (VMT), cost, and automobile use. It was found that VMT was not reduced by the project, and the system was not cost-competitive with existing demand-response services, at least as implemented within the research and development context; nevertheless, it served as a new affordable travel mode for users in the region. These and other findings suggest that although the project was well-intentioned, regions of deployment need to be considered for suitability with the project design.

Executive Summary

This report presents the results from an independent evaluation of the Regional Transportation Authority (RTA) of Pima County's Adaptive Mobility with Reliability and Efficiency (AMORE) project, one of 11 Mobility on Demand (MOD) Sandbox Demonstrations partially funded by the Federal Transit Administration (FTA). The independent evaluation was sponsored by the U.S. Department of Transportation (USDOT) Intelligent Transportation Systems Joint Program office (ITS JPO) and FTA.

The Tucson region is the 2nd largest metropolitan region in Arizona and by population among the largest 60 metropolitan regions of the country. Like many US metropolitan regions, particularly those that experienced significant growth in the 20th century, the urban landscape of Tucson is auto-oriented, low-density, and difficult to service effectively with fixed-route transit. As a result, municipal and transit agencies in the region have been seeking ways to deliver more flexible services, in terms of both serving origins and destinations and enabling more dynamic scheduling.

The AMORE pilot project operated from October 2018 to May 2019 and sought to advance these objectives by augmenting Rita Ranch's current transit-only service with an integrated multimodal, community circulation-based mobility service that could be accessed, paid for, and managed through a single platform. Key strategies were establishing a financially-sustainable mobility ecosystem; introducing a subscription-based transit-hailing service (RubyRide) as a viable and affordable option for commuting or first-/last-mile service for public transit operations; achieving a higher use and occupancy; and seamlessly integrating community-based social-carpooling (via Metropia Driving Up Occupancy [DUO]) with the subscription-based Ruby Ride and existing public transit services to make the total system capacity dynamic, adaptive, and capable of meeting peak-hour demand. The project was implemented with RTA, Metropia, and Ruby Ride, and users engaged the system through an app that enabled them to book door-to-door service with the project pilot regions.

Data were collected between June 2018 and July 2020. In accordance with the evaluation plan, a survey of project users evaluated how they engaged with and responded to the project; in total, there were only 15 users of Ruby Ride over the course of the project. Surveys were deployed in July 2020, with one reminder message sent. Ultimately, the evaluation of behavioral impacts was limited due to the very small survey sample size—the survey of users who had a recent trip with the system had an N = 2, and a more extensive retrospective survey had an N = 4.

Activity data were used to evaluate the performance of the system in terms of vehicle miles traveled (VMT), cost, and automobile use. It was found that

VMT was not reduced by the project, and the system was not cost-competitive with existing demand response-services, at least as implemented within the research and development context; nevertheless, it served as a new affordable means of travel for users in the region. A key lesson learned was that the region selected for deployment was not the well-suited for this type of project; the exurban environment required people to regularly travel 10–20 miles out of the area served by the pilot to reach their destinations, so the project could not effectively serve their needs. These and other findings suggest that although the project was well-intentioned, regions of deployment need to be carefully considered for suitability with project design.

The report explores the project through the evaluation of 10 hypotheses.

Hypothesis 1: The average number of modes that travelers use increases.

Due to the limited response to the survey, this hypothesis was not addressable. The survey contained questions about the modes travelers used and the change in frequency of use of those modes as a result of the project. However, the number of survey responses (N = 2) was not sufficiently large to appropriately address this hypothesis. Thus, Hypothesis 1 was found to be inconclusive.

Hypothesis 2: Public transportation ridership, including service offerings that are part of program, will increase due to AMORE.

Due to the limited survey response, only limited conclusions could be made regarding this hypothesis. In total, 697 trips were taken with RubyRide in the pilot area during the pilot. Ridership likely did increase because, inevitably, some of those 697 trips would not have otherwise occurred with public transit in the absence of the project. Under the definition of the service being a part of the public transit system, the project's incorporation of RubyRide services increased ridership; thus, in the strictest interpretation of the hypothesis, the AMORE project increased public transportation ridership (because RubyRide rides were considered ridership). Trends in RubyRide ridership showed that there was an initial increase in ridership in late 2018 that was sustained through the end of the year; however, ridership dropped off in early 2019, particularly after one frequent user ceased using the service. There is little evidence that the AMORE services augmented the traditional use of fixed-route public transit services in place prior to the project. Although usage early in the deployment suggests that RubyRide offered utility to local customers within the deployment area, there is limited evidence that it increased overall public transit ridership within the region. As a result, Hypothesis 2 was found to be inconclusive.

Hypothesis 3: Older adults and those with no vehicle access find that AMORE provides affordable mobility options for work or social activities that they would otherwise forgo or defer.

Due to the limited response to the survey, few conclusions could be made regarding this hypothesis. The survey asked questions about user age and other demographics and about their general perception of the system as an affordable option. However, due to the small sample size associated with the response, Hypothesis 3 could not be evaluated and was therefore inconclusive.

Hypothesis 4: Parents carpool more when driving minors as a result of AMORE.

Due to the limited response to the survey, this hypothesis could not be evaluated. The survey asked questions about carpooling activity of households as a result the project. However, as the hypothesis was evaluating shifts in behavioral impact of a specific demographic type and demographic information was not included in the available activity data, only limited conclusions could be made regarding this hypothesis. Hypothesis 4 was found to be inconclusive.

Hypothesis 5: Users of AMORE will reduce their personal automobile use.

The original design of the evaluation sought to address this hypothesis using survey data. Survey questions were included to explore how users may have shifted travel modes as result of the project. RubyRide trips were delivered in personal automobiles, where drivers delivered mobility services for passenger (as with traditional Transportation Network Companies [TNCs]). Because of this, there is little evidence to suggest that the project reduced the use of personal automobile trips. Trips were also generally single-occupant or conducted by members of the same household. As a result, and because there was a significant overlap of origins and destinations, there is little evidence to suggest that users of AMORE reduced the use of personal automobiles because of the project. Findings based on the limited data suggest that Hypothesis 5 was not supported.

Hypothesis 6: VMT will fall among users of AMORE (by use case/segment—older adults, school trips, commuters).

The AMORE project ultimately had an impact on net VMT. To evaluate the range and distribution of possible VMT changes, a simulation of mode substitution was executed with the activity data. Specific mode substitutions as informed by a distribution of responses to the recent trip survey (N=4) were repeatedly assigned to different trips, and results showed that the range of net VMT change was an increase of 1,400–2,000 miles throughout the duration of the project. Ultimately, there were few plausible pathways through which the project could effectively reduce VMT. Regardless of how mode shift was distributed across

trips, the presence of the system likely increased VMT. This finding is supported by the fact that, as identified in the survey, some trips would have been by walking or bicycling but were instead shifted to automobile. This shift naturally increases VMT. Other trips were substituting automobile travel for automobile travel. Such substitutions do not substantively change VMT, but they also do not reduce it. Taken together, the results suggest that Hypothesis 6 was not supported.

Hypothesis 7: AMORE provides Mobility as a Service (MaaS)/Mobility on Demand (MOD) services that lower per-trip cost to operators and provide additional affordable options for consumers.

Cost data were analyzed to evaluate whether the project provided services at costs that were competitive with existing demand-response services. According to data from FTA's National Transit Database (NTD), overall demand-response services provided in Pima County in 2019 were delivered at a cost of $12.06 per unlinked passenger trip and $2.83 per revenue mile. The major provider of these services in the region was SunVan, and a localized neighborhood service for Americans with Disabilities Act (ADA) eligible passengers delivered by RTA, Sun Shuttle, was delivering services at a cost of $6.96 per trip according to agency-provided data. Across all demand-response services in Pima County, RTA delivers a cost per trip for demand-response services that is lower than that for fixed-route bus services ($16.87). The overall project cost divided by the number of trips provided by RubyRide suggests that the project cost $1,213 per AMORE trip and an estimated $269 per passenger mile. Although these costs represent overall project costs, including research and development, administration, and other operational costs, the difference in cost per trip and per mile is considerable. As such, it is unlikely that the services were lower in cost than conventional demand-response system costs. Overall, the AMORE project was not cost-effective in providing mobility services for the agency, but it did provide users with an affordable mobility option because trips were delivered at zero cost to the user. As a result of this mix of findings, Hypothesis 7 was found to be partially supported.

Hypothesis 8: AMORE increases carpooling among Tucson residents.

The evaluation plan had a strong reliance on the survey to address this hypothesis. The survey included questions to address carpooling activity and impacts, but given the lack of survey sufficient data, not enough information was available to evaluate this hypothesis. Hypothesis 8 could not be evaluated and was found to be inconclusive.

Hypothesis 9: The integration of these mobility options into the Metropia application increases the use of RubyRide and Metropia.

As determined with Hypothesis 2, analysis of user activity found that the use of RubyRide increased initially during the pilot in late 2018 but was driven largely by a small number of frequent users. Use dropped off in early 2019 when a few frequent users ceased their activity. The survey was designed to support the evaluation of this hypothesis by asking respondents how often they used AMORE services and how it impacted their use of available modes. Ultimately, the data available and the usage levels of the service were not sufficient to evaluate Hypothesis 9, which was thus found to be inconclusive.

Hypothesis 10: The process of deploying the project will produce lessons learned and recommendations for future research and deployment.

The project team was interviewed through a series of stakeholder/project partner interviews conducted in August 2019 to extract lessons learned from the experience of project implementation. Organizations interviewed included the Pima Association of Governments, Metropia, Sun Tran, and RubyRide. The interviews revealed six key lessons learned identified during the project related to service area selection, labor, insurance, marketing, wheelchair-accessible vehicles (WAVs), and technical challenges, including the onboarding process.

Project partners came to the realization that the service area suffered from low ridership, in part due to poor market research and lack of destinations within the area. The service area was not selected because of demand but because it had certain institutional attributes, such as low-frequency transit service with limited ridership. Rather than try to develop a service to meet an unmet mobility need, a primary goal of the service area was to design a service that replaced the existing fixed-route service. However, the project partners realized that people were interested in being picked up and taken to a different part of Tucson; it was difficult to find riders interested in taking trips within the originally-conceived small service area, in part because there were no major employers or destinations therein. The project partners considered moving the service location and/or adding specific pick-up and drop-off points outside the service area (e.g., downtown, airport, etc.), but RTA opted not to do this due to budget constraints and instead expanded the service area slightly to an adjacent community (Vail), adjacent to the south of Rita Ranch. Interviewees described this effort as “too late,” as the service area change occurred during the last 1–2 months of the pilot.

With respect to labor, the AMORE project highlighted a key trade-off between the cost and reliability of MOD partnerships in low-density and off-peak service environments. TNC service in lower-density and rural areas often is unreliable, with a high likelihood that no drivers will be available. To overcome

this challenge, contractors must be provided with guaranteed hours to make it worthwhile for them to be on standby. This creates a high, fixed operational cost in spite of offering better reliability. RTA hired drivers and paid them an hourly wage ($12), but this decision and keeping a certain number of drivers on-call led to the depletion of funds more quickly than if drivers had been dispatched and paid on a per-trip model.

Insurance was a notable challenge that delayed the project and almost prevented it from getting off the ground. Project partners found that insurance companies were not willing to insure the TNC model because drivers were using their own vehicle. It was eventually decided to work with an insurance provider that required ZenDrive, a third-party application that uses smartphone sensors and algorithms to predict risk and shares these data with the insurance provider. ZenDrive integration represented a notable challenge for RTA and delayed the development timeline because Metropia had to build an application programming interface (API) to connect with ZenDrive.

The project partners realized that marketing AMORE was key after learning that the public has preconceived notions about TNCs (safety, surge pricing, unreliable service in low-density areas, etc.) that had to be overcome through education and outreach. The project developed a community engagement strategy that included marketing, helping on-board users to the pilot program, and forming liaisons between drivers and the technology team to assist the development of in-app communications and training documents. Interviewees also noted the importance of diversifying stakeholder outreach and expressed the importance of marketing flexibility through a range of formats including newsletters, flyers, press releases, stories in local newspapers, and targeted social media advertising. However, it was quickly learned that due to the small geographic area and population size, targeted geographic marketing could not be done as part of a digital media campaign.

RubyRide believed that it could purchase a WAV and submit it to RTA for reimbursement but quickly learned it had to go through the procurement process. Instead, a third party ended up purchasing the vehicle and leasing it to RubyRide with a vehicle wrap for branding. Additionally, it was believed that there would be more WAV trip requests than there were in practice. In hindsight, the project partners believe that the low demand for WAV trips was probably likely due to users already using SunVan.

Interviewees described a number of small technical challenges in the early roll-out of the pilot, such as trips that were dispatched and dropped from the system and other technical challenges specific to the Android version of the app. Interviewees also expressed the importance of closely monitoring the service area map to ensure proper geocoding so users can drop a pin or enter an address at all desired destinations within the service area. Additionally, due

to the nature of the pilot, the app could not be downloaded from any app store, which required technical assistance from Metropia to help users.

Finally, during the on-boarding process, users were asked if they had a credit/debit card and smartphone access; those who needed to acquire a credit/debit card were encouraged to purchase a Visa gift card instead. In addition, a feature was available to allow people to request rides to address the digital divide, although this was ultimately not used, likely due to the limited overall user participation.

Moving forward, RTA anticipates that the software features developed for the MOD Sandbox project will be applied to the region's paratransit program, which could result in a 20% improvement in paratransit operational efficiency (as measured by average cost per trip). Additionally, RTA and Sun Tran hope to take the lessons learned from the MOD Sandbox project and apply them to other contexts, such as a bus route closer to an urban center that runs through an underserved community to connect neighborhoods to nearby commercial centers and community resources. However, a key challenge will be determining how to transfer unbanked riders dependent on cash payment and place them into a transportation program that has traditionally been dependent on cashless payment. RTA and Sun Tran plan to use the lessons learned from the pilot to better define optimum service area size, right-size vehicles, refine the concept, and improve community outreach for an underserved communities.

Table ES-1 presents a summary of findings for the evaluation hypotheses.

Table ES-1 *Summary of Findings*

	Hypothesis	Status	Key Finding
1	The average number of modes that travelers use increases.	Inconclusive	Insufficient information to evaluate this hypothesis.
2	Public transportation ridership, including service offerings that are part of program, will increase due to AMORE.	Inconclusive	Limited information available to evaluate this hypothesis. AMORE project used by 15 people; as AMORE trips are considered public transit ridership, by definition, ridership can be assumed to have increased. However, little evidence to support any substantive change in use of conventional public transit services within region as result of AMORE.
3	Older adults and those with no access to a vehicle find that AMORE provides affordable mobility options for work or social activities that they would otherwise forgo or defer.	Inconclusive	Because of limited survey data, not enough information on demographics of riders to evaluate whether AMORE connected older adults with activities that would not have been used in its absence. Project design made this possible, but it could not be confirmed.
4	Parents carpool more when driving minors as a result of AMORE.	Inconclusive	Not enough information available to evaluate this hypothesis nor to confirm it.

Table ES-1 (cont.) *Summary of Findings*

	Hypothesis	Status	Key Finding
5	Users of AMORE will reduce their use of personal automobiles.	Not supported	Findings of activity data analysis suggest that use of personal automobiles either did not change or increased due to project.
6	VMT will fall among users of AMORE (by use case/segment: older adults, school trips, commuters).	Not supported	Findings of activity data analysis suggest that user VMT either did not change or increased due to project.
7	AMORE provides MaaS/MOD services that lower per-trip cost to operator and provide additional affordable options for consumers.	Partially supported	Trip costs of AMORE priced at a level affordable and competitive to most other modes, and many trips were free. Cost of project on per-trip basis suggests that agency spending per trip was not competitive with average per-trip operating expenses of conventional demand-response transit within region.
8	AMORE increases carpooling among Tucson residents.	Inconclusive	Not enough information available to evaluate this hypothesis nor to support it.
9	The integration of these mobility options into Metropia increases the use of RubyRide and Metropia.	Inconclusive	Usage levels and available data not sufficient to evaluate this hypothesis.
10	The process of deploying the project will produce lessons learned and recommendations for future research and deployment.	Supported	Project was ambitious undertaking to deliver innovative mobility services to low-density exurban environment. Service area of project was found to be problematic due to lack of destinations, which limited utility of project to residents within service area, as many wanted to be taken outside service area. Low-density areas in Tucson determined to be less ideal for project of this type due to low public transit ridership and relatively low congestion.

Section 1 Introduction

Overview of MOD Sandbox Demonstrations

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

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

More information about the MOD Sandbox Program can be found at https://www.transit.dot.gov/research-innovation/mobility-demand-mod-sandbox-program. Table 1-1 provides a summary of all projects in the MOD Sandbox Program.

Table 1-1 *Overview of MOD Sandbox Projects*

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

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

This report focuses on the evaluation of the MOD Sandbox Demonstration project with the Regional Transportation Authority (RTA) of Pima County implemented in the Tucson metropolitan area. The project, Adaptive Mobility with Reliability and Efficiency (AMORE), consisted of collaboration between RTA, Metropia, and RubyRide to transform the existing fixed-route transit system, improve overall system reliability and efficiency, and increase ridership while delivering a seamless user experience. The evaluation of this project involved exploring several hypotheses surrounding the project's impact on travel behavior, user experiences, and costs. Following a more detailed overview of the project, these hypotheses are explored in the sections that follow.

Evaluation Framework

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

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

Section 2

AMORE MOD Sandbox Project Summary

The Regional Transportation Authority (RTA) of Pima County, the fiscal manager of the $2.1 billion, 20-year RTA plan, provides public transportation services to all jurisdictions comprising the Tucson metropolitan area. The RTA is managed by Pima Association of Governments (PAG), the region's metropolitan planning organization and provides fixed-route, ADA-compliant and optional paratransit, and general public dial-a-ride service. The daily operations of all services are managed through a contract with Total Transit, a private transportation company. RTA services function primarily as geographic extensions and service-hour expansions to the region's primary transit system, Sun Tran, managed by the City of Tucson. The Sun Shuttle system provides extended coverage to outlying areas, and RTA-funded weekday evening and weekend service-hour expansions provide regional transit users with augmented off-peak transportation options.

The Adaptive Mobility with Reliability and Efficiency (AMORE) project sought to enhance mobility access to work and other needs, reduce personal car dependency, integrate attributes of multiple emerging mobility services and technologies, and deliver additional options for travel to local residents. The project pilot was launched in the greater Rita Ranch area in southeast Tucson between June 2018 and June 2019, which is served by a traditional fixed-route transit system. The Rita Ranch area is a relatively low-density, auto-oriented exurban community with limited fixed-route transit and low ridership. The service area in Rita Ranch was selected because it had certain attributes such as low frequency of public transit service with limited ridership. Instead of trying to develop a service to meet an unmet mobility need, a primary goal was to design a service for the area that could replace pre-existing fixed-route service. RTA faced a common dilemma for transit operators in the service area—it operated a financially-constrained service with limited capacity and coverage of the region and also had challenges delivering service with sufficient flexibility to service the land use of the region. This led to insufficient demand, further limiting RTA's ability to innovate, increase ridership, and meet local accessibility and mobility needs.

TNCs have been steadily gaining in popularity in recent years by providing flexible on-demand transportation using personal vehicles that often are right-sized for the level and dispersed destination nature of travel demand within the area. The AMORE project piloted and evaluated augmenting Rita Ranch's current transit-only service with an integrated multimodal, community circulation-based mobility service that could be accessed, paid for, and managed through a single platform. The RubyRide system would deliver a network of on-demand, demand-responsive, pooled rides through use cases similar to those provided by TNCs.

The project pursued several high-level goals. A key goal was to establish a financially-sustainable mobility ecosystem with a credit system within which credits could be subscribed, purchased, earned, and transferred among families and friends via a range of activities to meet mobility needs. The credits could be purchased for a number of trips at an associated point "allowance." Credits were redeemable via the Metropia Driving Up Occupancy (DUO) app and could be used on any service in the Metropia app. Modes included in the app were planned to consist of driving (via a personal vehicle), carpooling (via Metropia PlanDUO), transit-hailing (via RubyRide), and public transit (via fixed-route services included in the app).

Subsequent versions of the app were considered that would have included the additional mode of e-bikes (via an electric bikeshare service) and additional options within the transit-hailing mode (via Uber and Lyft). Ultimately, these additional versions were not implemented. Another goal of the project was to introduce a subscription-based transit-hailing service called RubyRide as a viable and affordable option for commuting as well as providing a first-/last-mile service for transit operations. The project aimed to improve public transit use and occupancy (e.g., reduced vehicle miles traveled [VMT] at a lower cost than other TNC services). The third objective was to integrate community-based, social carpooling (via Metropia DUO) with the subscription-based RubyRide and existing public transit services to make total system capacity more dynamic, adaptive, and capable of meeting the peak-hour demand surge.

The project produced a number of lessons learned for the future development of MOD services within the region related to service area selection, labor, insurance, marketing, wheelchair- accessible vehicles (WAVs), and other technical challenges. Future software development stemming from the project are also anticipated to be applied to the region's demand-response program. For example, Metropia believed that the integration of its software into the region's demand-response program could produce a 20% improvement in demand-response operational efficiency.

Additionally, RTA and Sun Tran hope to take the lessons learned from the MOD Sandbox Demonstration and apply them to other contexts. For example, one application being considered could apply to a bus route running closer to an urban center that runs through an underserved community to connect it to nearby commercial centers and community resources. However, a key challenge for execution is serving unbanked riders who are dependent on cash payment with a transportation program that traditionally operates with cashless payment. To meet these and other objectives, RTA and Sun Tran expect to make improvements related to optimum service area size, right-sizing vehicles, refinements to the concept, and community outreach to disadvantaged communities.

This report provides the design and results of the independent evaluation of the AMORE project.

Project Timeline

The main project milestones are captured in the following timeline:

- **June 2017**– Cooperative Agreement execution date
- **October 2018** – Demonstration start (first RubyRide trips)
- **June 2019** – Demonstration completion

The RTA team collected data relevant to this project (as outlined in this Evaluation Plan) between June 2018 and July 2019 and shared available data with the IE team for conducting the evaluation

Section 3

Evaluation Approach, Planning, and Execution

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

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

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

Table 3-1 *Evaluation Hypotheses, Performance Metrics, and Data Sources for RTA Sandbox Project*

Number	Project Goals	Evaluation Hypothesis	Performance Metric	Data Elements	Data Sources
1	Increase diversity of use of mobility options.	The average number of modes that travelers use increases.	Number of mobility options used by commuters	[User] Travel activity data, survey data	Metropia, survey of Amore users
2	Increase public transportation ridership within the greater Rita Ranch area.	Public transportation ridership, including service offerings that are part of program, will increase due to AMORE.	Public transit ridership	Public transit ridership data, survey data	Regional Transportation Authority, survey of AMORE users
3	Increase in mobility for older adults and those with no access to vehicles.	Older adults and those with no access to a vehicle find that AMORE provides affordable mobility options for work or social activities that they would otherwise forgo or defer.	Reported mobility (and perception of mobility options) among described demographics	Survey data	Survey of AMORE users
4	Increase in carpooling by parents when driving minors as a result of AMORE.	Parents carpool more when driving minors as a result of AMORE.	Reported carpooling patterns by parents of minors before and after AMORE implementation	Survey data	Survey of AMORE users
5	Reduce personal car dependency for travel.	Users of AMORE will reduce their use of personal automobiles.	Before and after use of personal automobiles by trips	Survey data	Survey of AMORE users
6	Reduce overall VMT (by segment/ use case: older adults, school trips, commuters).	VMT will fall among users of AMORE (by use case/segment: older adults, school trips, commuters).	Measured VMT of travel activity (by use case/segment: older adults, school trips, commuters); before and after reports of VMT in survey	Vehicle attributes and activity data, [user] travel activity data, survey data	RubyRide, Metropia, survey of AMORE users
7	Increase affordable options for MaaS/ MOD services.	AMORE provides MaaS/MOD services that lower per-trip cost to operator and provide additional affordable options for consumers.	Difference in average cost per trip and per passenger mile of AMORE and comparable transit and SOV trips	[User] Travel activity data, activity data from RubyRide	Metropia, RubyRide

Table 3-1 (cont.) *Evaluation Hypotheses, Performance Metrics, and Data Sources for RTA Sandbox Project*

Number	Project Goals	Evaluation Hypothesis	Performance Metric	Data Elements	Data Sources
8	Increase carpooling.	AMORE increases carpooling among Tucson residents.	Reported carpooling from survey and activity data (if known)	[User] Travel activity data, survey data	Metropia, survey of AMORE users
9	Improve access to mobility options through integration of Metropia DUO, RubyRide, and transit into Metropia app.	The integration of these mobility options into Metropia increases the use of RubyRide and Metropia.	RubyRide and Metropia usage	[User] Travel activity data, survey data	RubyRide, Metropia, survey of AMORE user
10	Produce lessons learned through stakeholder interviews.	The process of deploying the project will produce lessons learned and recommendations for future research and deployment.	Qualitative documentation from stakeholder interviews	Stakeholder interview data	Interviewees from project partners

The quantitative and qualitative evaluation methods used in the RTA evaluation included the following:

- Activity data analysis
- Survey data analysis
- Summary of expert (stakeholder/project partner) interviews

The content of the logic model was translated into a data collection plan, which was incorporated into a broader evaluation plan. The evaluation plan contained further details on the proposed data structures and analytical approaches to address each hypothesis. The evaluation plan was reviewed by project stakeholders and finalized at the inception of the project. In the section that follows, the report presents more background on the data collected in support of the evaluation, followed by a presentation and discussion of the results from the evaluation.

Data Collected

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

- A recent trip survey and a retrospective survey were deployed. However, the sample size of both surveys was very small—N=4 and N=2, respectively. The low response rate was, in part, due to a relatively small population available for recruitment. Because of the low population and small sample size, survey data and the associated hypotheses relying on them could not be analyzed.
- Activity data of RubyRide and the SunVan demand-response system were provided. SunVan data spanned October 2018 to April 2019 and included information on attributes of individual passenger trips amounting to a total of 57,753 trips. The MOD_Area field in the SunVan dataset indicated which trips were within the MOD area vs. the broader Tucson region.
- Similarly-structured data were provided for RubyRide travel activity, comprising 697 trips spanning October 2018 to May 2019.
- Activity data for RTA paratransit provider Sun Shuttle were also provided for trips within the MOD region and given to ADA-qualified passengers, consisting of 599 trips spanning June 2018 to May 2019.
- Expert interviews were conducted in August 2019 with members of the AMORE project team, including members of the Pima Association of Governments, Metropia, Sun Tran, and RubyRide, which had deep knowledge of the project and covered lessons learned, challenges and barriers, and key institutional findings.

These datasets were applied to evaluate the hypotheses defined within the evaluation plan. The methods applied for the different analyses depended on the hypothesis being addressed. Due to the low number of responses, survey data were not usable for most analyses for which they were planned. The two main datasets used were those of the vehicle activity data and the expert interviews.

Trip activity data were augmented to include information about attributes of the same trips had they been taken by other modes. This consisted of calculating travel time (seconds) and travel distance (meters) for biking, walking, transit, and driving modes of transportation using a Google API with origins and destination coordinates of the original trip. In addition, the fuel economy of the vehicle used for the trip was obtained from the fuel economy database published by the US Environmental Protection Agency (EPA). Using the fuel economy and distance traveled, the emissions were calculated for each trip.

Timestamps within the data were used to calculate waiting time and travel time for each trip. These data were also used to evaluate whether switching from driving alone to another mode was feasible or practical for the traveler. This assessment was done by evaluating the time difference between the driving mode and all other transportation modes calculated. Mode shift was computed for several cases for different modes, and additional CO2 was calculated from

mode shifts away from zero-emission modes. Paratransit activity data had an additional indicator determining whether a trip was WAV and non-WAV. Average waiting time and travel time for each group could be calculated to evaluate differences.

There were a number of limitations to this evaluation, one of which related to survey data collection. The very small sample size of the survey data collected, despite two different implementations, limited the ability of the evaluation to address questions regarding behavioral impact. This small sample size was a function of a small population of recruitment. This limitation also reduced the data available to inform simulations of behavioral shift given activity data. Activity data, on the other hand, was relatively complete and comprehensive and contained information on travel times and locations that were used for evaluating specific metrics of system performance.

In the sections that follow, results of the hypotheses that could be evaluated given data availability and hypotheses that could not be evaluated (inconclusive) due to lack of appropriate data are presented.

Section 4

Evaluation Results

Hypothesis 1: The average number of modes that travelers use increases.

Performance Metric	Key Finding
Number of mobility options used by commuters.	Insufficient information to evaluate this hypothesis.

Due to the limited response to the survey, this hypothesis was not addressable. The survey contained questions about the modes travelers used and about the change in frequency of use of those modes as a result of the project. However, the number of survey responses (N = 2) was not sufficiently large to appropriately address this hypothesis. Hypothesis 1 was found to be inconclusive.

Hypothesis 2: Public transportation ridership, including service offerings that are part of program, will increase due to AMORE.

Performance Metric	Key Findings
Public transit ridership	Limited information available to evaluate this hypothesis. AMORE was used, and if these services are considered, then ridership can be assumed to have increased. However, there is little evidence to support any substantive change in conventional public transit services within the region.

Due to the limited response to the survey, there were limited conclusions that could be made regarding this hypothesis. The AMORE system had some use, with 697 trips booked with RubyRide during the pilot. Of those, 683 were completed and 14 were canceled. Given that these services were part of the program, as some trips occurred with AMORE, in the strictest definition of the hypothesis, ridership likely did increase because some of those 697 trips would have not have otherwise occurred with transit in the absence of the project. However, there is little evidence that the AMORE services augmented the traditional use of fixed-route public transit services in place prior to the project. Figure 4-1 shows the trend RubyRide trips over the course of the project.

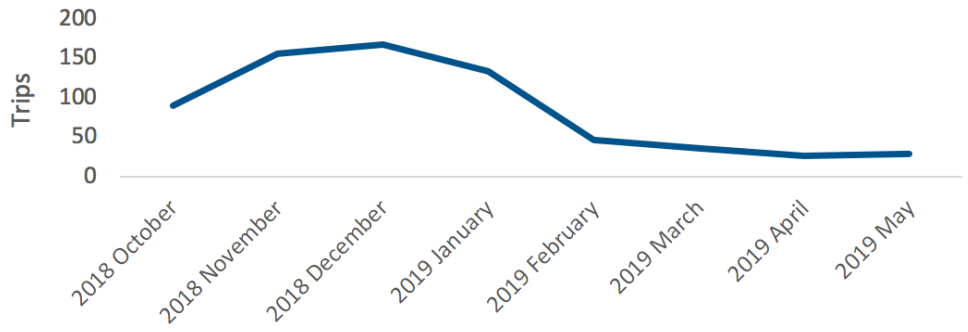

Figure 4-1 *Ruby Ride Trips, October 2018–May 2019*

The trends in Figure 4-1 show that RubyRide experienced relatively vigorous use during the final months of 2018. However, usage dropped considerably during the early months of 2019. RubyRide had 15 unique users driving this activity; a single user accounted for 319 of the 683 trips completed. The drop in activity noted in February 2019 was because this individual ceased their use in February after completing 64 trips in January 2019 and 108 trips in December 2018. Another user completed 133 of the 683 trips and continued their user at a rate of about 17 trips per month. This and activity by a few other users resulted in continued activity from February to May 2019 at lower levels. Overall, although usage early in the deployment suggests that RubyRide offered utility to local customers within the deployment area, there is limited evidence that it increased the overall public transit ridership within the region. Hypothesis 2 is found to be inconclusive.

Hypothesis 3: Older adults and those with no access to a vehicle find that AMORE provides affordable mobility options for work or social activities that they would otherwise forgo or defer.

Performance Metric	Key Finding
Reported mobility (and perception of mobility options) among the described demographics.	Insufficient demographic data collected by survey to address this hypothesis.

Due to the limited response to the survey, few conclusions can be made regarding this hypothesis. The survey asked questions about age and other user demographics and about the general perception of the system as an affordable option. However, due to the small sample size associated with the response, Hypothesis 3 could not be evaluated and was therefore inconclusive.

Hypothesis 4: Parents carpool more when driving minors as a result of AMORE.

Performance Metric	Key Finding
Reported carpooling patterns by parents of minors, before and after AMORE implementation	Not enough information available to evaluate or to confirm this hypothesis.

Due to the limited response to the survey, this hypothesis could not be evaluated. The survey asked questions about carpooling activity of households as a result the project. However, as the hypothesis was evaluating shifts in behavioral impact of a specific demographic type and demographic information was not included in the available activity data, few conclusions could be made regarding this hypothesis. Hypothesis 4 was found to be inconclusive.

Hypothesis 5: Users of AMORE will reduce their use of personal automobiles.

Performance Metric	Key Finding
Before and after use of personal automobiles by trips	Findings of activity data analysis suggest that use of personal automobiles either did not change or increased due to the project.

The original design of the evaluation sought to address this hypothesis using survey data. Questions in the survey were to explore how user travel modes may have shifted as result of the project. RubyRide trips were delivered in personal automobiles; because of this, there is little evidence to suggest that the project reduced the use of personal automobiles. Figure 4-2 shows the origins and destinations of Ruby Ride trips in the MOD region during the project from October 2018 to May 2019, indicating that origins and destinations naturally overlapped significantly, because most travel was automotive in nature and required round-trip service.

Figure 4-2 *Origins and Destinations of RubyRide Trips during Project*

Trips also were generally single-occupant or conducted by members of the same household. As a result of this and the significant overlap of origins and destinations, there is little evidence to suggest that users of AMORE reduced their use of personal automobiles because of the project. The findings based on limited data suggest that Hypothesis 5 was not supported.

Hypothesis 6: VMT will fall among users of AMORE (by use case/segment: older adults, school trips, commuters).

Performance Metric	Key Finding
Measured VMT of travel activity (by use case/segment: older adults, school trips, commuters) Before and after reports of VMT in the survey	Measured VMT of travel activity did not decrease as a result of AMORE.

The AMORE project enabled riders to book their ride within the MOD service area, which had an impact on net VMT as directly correlated to fuel consumption. User behavioral changes measured through the survey in addition to user travel activity data recorded were jointly analyzed to evaluate the change in VMT. To better understand mode shift, the recent trip survey (N=4) asked respondents questions about how they would have traveled in the absence of AMORE. One question probing this shift focused on the most recent trip made with AMORE. As noted, the sample size was extremely limited; absent sufficient survey data, assumptions on mode shift were needed to evaluate the hypothesis. Respondents were asked how they would have made the trip if AMORE was not available. Figure 4-3 presents the distribution of responses to this question.

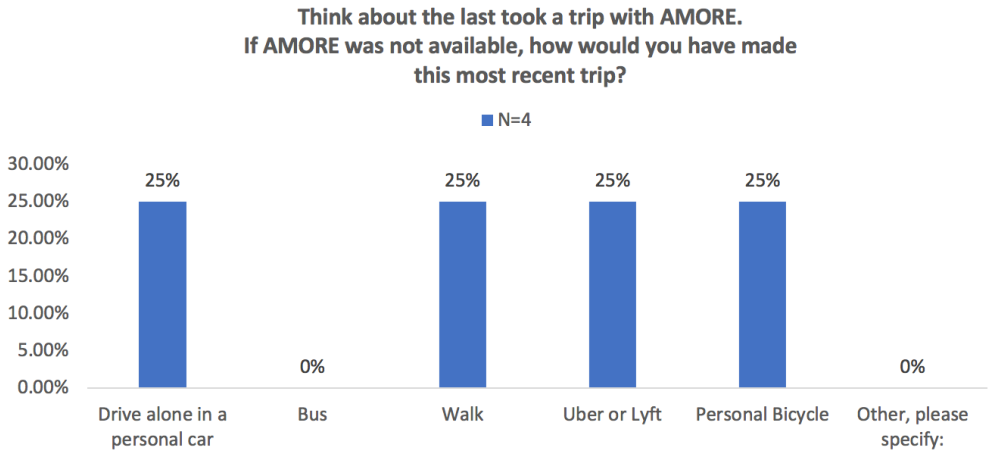

Figure 4-3 *Mode Substitution as a Result of AMORE*

The sample size of survey data was too small to measure user behavioral change by itself. The distribution of responses shows that 25% of respondents would have driven alone in the absence of AMORE and another that 25% would take Uber or Lyft; thus, 50% of AMORE users were substituting it for travel in a single-occupant personal vehicle. On the other hand, other mode substitutions reported included walk (25%) and bike (25%), which suggests that 50% of respondents would increase the VMT and fuel consumption as a result of using AMORE.

Although the sample size was too limited to be considered a reliable data source, the distribution was applied to establish a base analysis, which would otherwise be covered by assumptions. The data suggest that roughly 50% of respondents would have implemented some form of single-occupant vehicle shift if AMORE was unavailable for their most recent trip. Considering this, an estimate of the resulting change in VMT can be generated to address the hypothesis.

To generate a rough estimate of the likely direction of VMT change, riders were randomly assigned a mode shift within the dataset. Based on those assignments, mode shift combinations were generated for each trip in the dataset and were used to generate directions of VMT change based on mode shift they chose to use if AMORE was not available. Based on the assigned direction of VMT change, the change in VMT was calculated. The net change in VMT was summed across all 697 trips in the dataset. These random assignments were repeated in bootstrapping simulation 1,000 times to check for robustness and sensitivity of the overall VMT change to redistributions of individual mode shift. The distributions resulting from these simulations are shown within Figure 4-4.

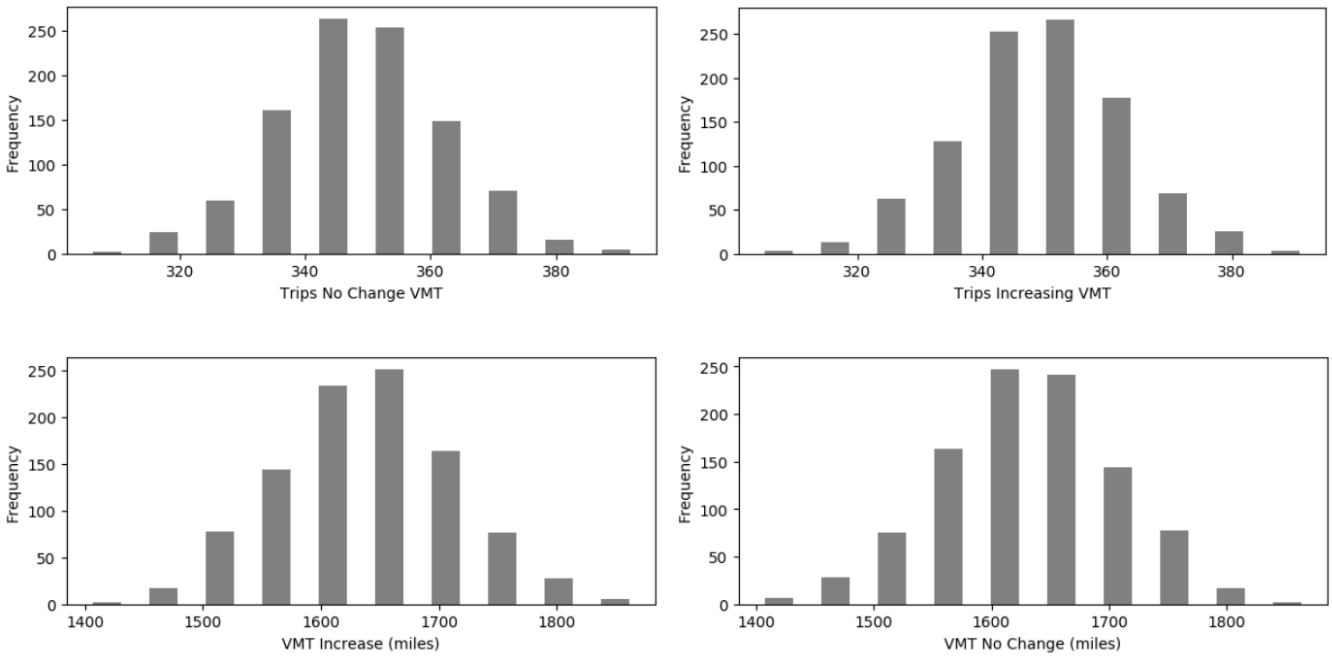

Figure 4-4 *Simulated VMT Shift Distributions, October 2018–May 2019*

The results of the simulation show that range of net VMT change is 1400–2000, as shown in Figure 4-5. Effectively, regardless of how mode shift is distributed across trips, the presence of the system likely increased VMT. This finding is somewhat expected given that the mode shift distribution enabled some trips that might have been taken by walking or bicycling were instead shifted to automobile. Notably, the mode shift distribution suggests that few users would have shifted their trip from public transit, which is, in part, derived from the fact that the region had low transit ridership. Collectively, these findings suggest that Hypothesis 6 was not supported.

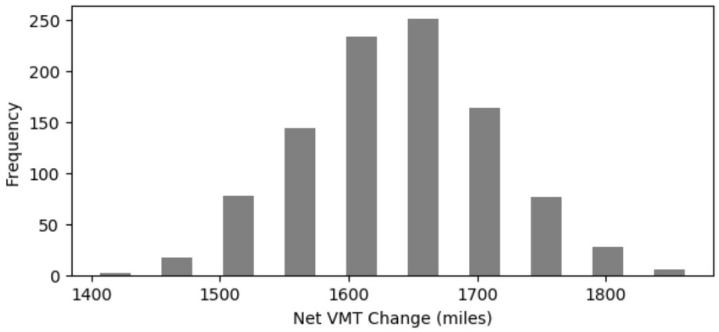

Figure 4-5 *Simulated Net VMT Change, October 2018–May 2019*

Hypothesis 7: AMORE provides MaaS/MOD services that lower per-trip cost to operator and provide additional affordable options for consumers.

Performance Metric	Key Findings
Difference in average cost per trip of AMORE and comparable transit and SOV trips,	Cost of trip by AMORE priced at a level affordable and competitive with most other modes. Many trips were free. Cost of project on per-trip basis suggests that agency spending per trip was not competitive with average per-trip operating expenses of conventional demand-response transit in region.

Cost data were analyzed to evaluate whether the project provided services at costs that were competitive with existing paratransit services. The overall project cost divided by the number of trips provided by RubyRide suggests a cost of $1,237 per AMORE trip and an estimated $269 per passenger mile. According to data from FTA's National Transit Database (NTD), demand-response services provided in Pima County are delivered at a cost of $12.06 per unlinked passenger trip and $2.83 per revenue mile. Most demand-response services are delivered by SunVan, which had a considerable amount of ridership over the same period (57,763 trips); this higher volume of trips can reduce the per unit cost of trips.

For comparative purposes, Figure 4-6 shows the spatial distribution of SunVan activity during the course of the project. The upper maps show the SunVan trips that just occurred within the MOD region; the lower maps show the broader volume of trips across the Tucson region; maps on the left are pick-ups and maps on the right are drop-offs. There is almost a complete overlap across the spatial distributions found with the RubyRide activity data. This suggests that SunVan was engaged in considerable round-trip activity. Both RubyRide and SunVan likely operated in this way due to the low density of land use in the region and the limited need for connections to public transit when using a direct point-to-point service.

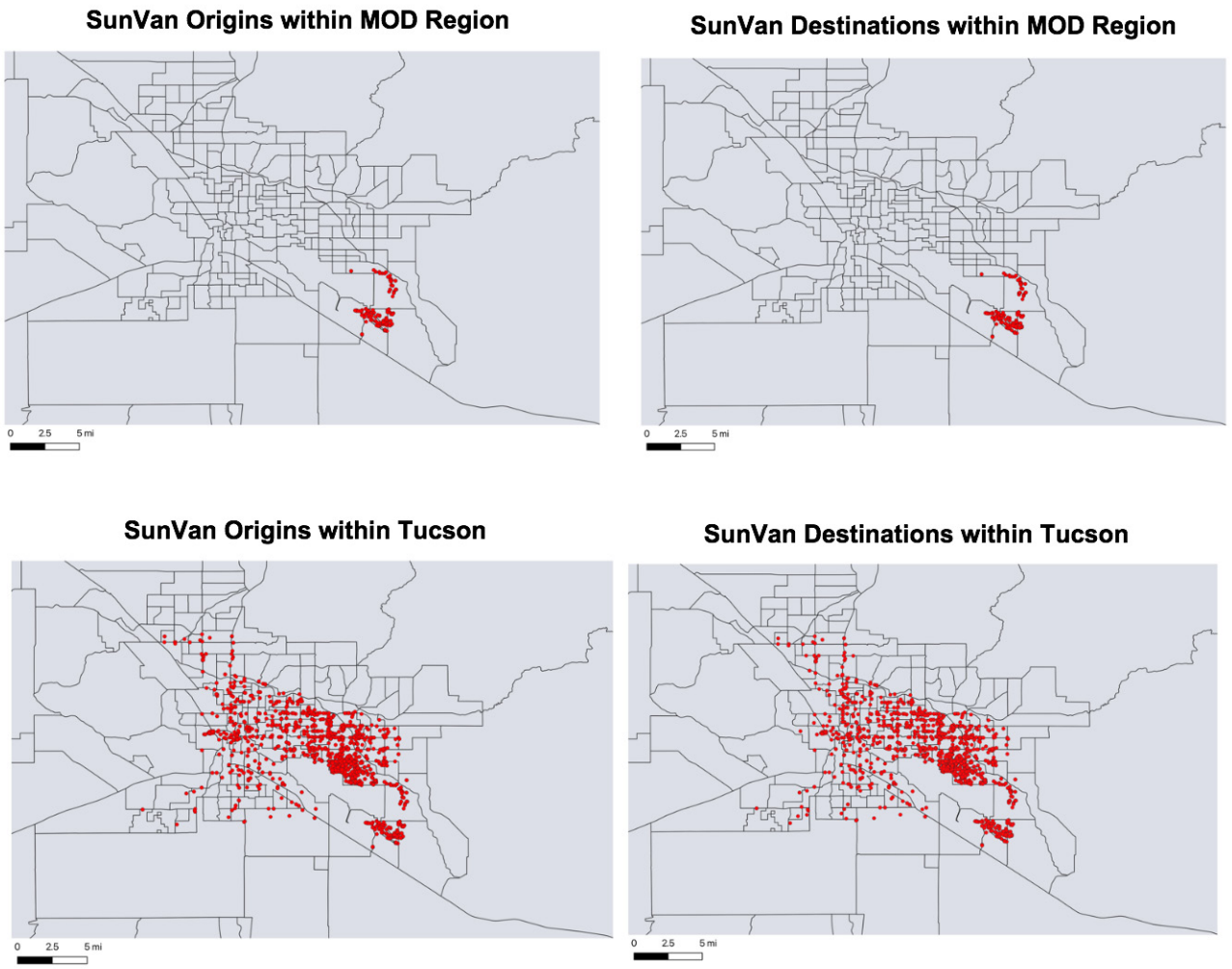

Figure 4-6 *Spatial Distribution of SunVan Activity, October 2018–April 2019*

The maps show that that SunVan had a far greater volume of trips and a far greater spatial distribution of activity over a slightly shorter time frame. Analogous to Figure 4-1, Figure 4-7 shows the trend of SunVan trips during the course of the pilot project.

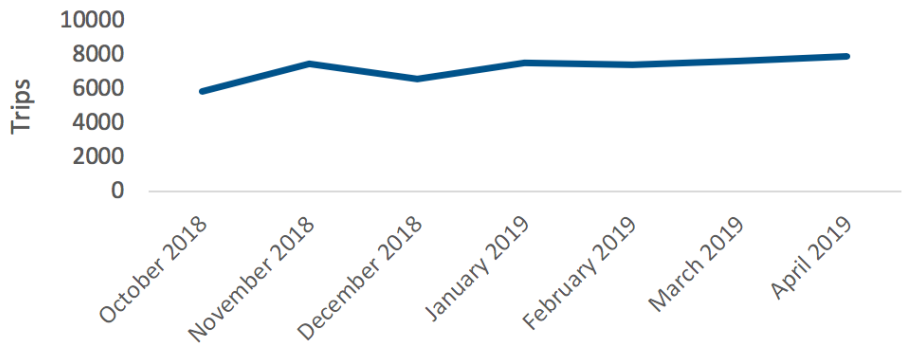

Figure 4-7 *SunVan Trips, October 2018–April 2019*

The higher and consistent volume likely reduced SunVan's per-unit trip costs considerably. Trip and cost data on an additional demand-response operator was provided by RTA over the course of the project and included information on trip details and the net trip cost of the trip to RTA. These trips were a subset of all trips by the provider, in that they were entirely delivered either to or from the region served by the Sandbox project (but these trips were not part of the project); they also consisted of entirely ADA-qualified passengers. Of the 599 trips within the provided dataset, 112 were provided with a WAV, 16 were provided in a six-passenger van, and the rest were provided in a sedan. The fare paid by passengers was either $3.20 or $6.00 depending on the distance traveled (zone-based). Total revenue from these trips was $1,998, and the net cost to RTA was $41,690.58 for this subset of trips. On a per-trip basis, trips were delivered at a cost of about $6.99 per trip. This higher cost, relative to the broader per trip cost of $12.06 for demand-response services within the broader RTA region, may partially reflect a combination of the region of service delivery and the accommodations required to service ADA passengers. Comparison to the project is not entirely congruent, as none of the trips started/ended within the MOD region. Still, the per-trip costs provide a more regionally-specific cost metric on service delivery within the region covered by the project.

It should be noted that the comparison of overall project costs, which include research and development costs, to the costs of existing demand-response services, is not a fair comparison. There is always considerable overhead associated with the development of new and experimental services that cannot be discounted. These development costs lead to advancements and experimentation that can drastically reduce cost if they are fruitful but are often incurred up front, with few trips delivered as a result. AMORE services were provided to users at no cost, which is competitive with all other motorized travel options. As a result, the project did successfully provide additional affordable options to consumers. Overall, the costs incurred by the project relative to the number of trips delivered suggested that the cost of trip delivery would have to

fall by a factor of 100 to be competitive with the relative efficient cost per trip delivered by the demand-response services of the broader RTA of Pima County, but by a factor of about 18 to be competitive with the ADA passenger service provided locally to the project service zone. It is also important to note that demand-response services within RTA are uniquely competitive. RTA of Pima County delivers a cost per trip of demand-response services that is lower than that of the cost per trip of fixed-route bus services ($16.87). This inversion of cost per trip of demand-response services is unusual for a public transit agency. Fixed-route services often are more efficient due to high passenger volume and high vehicle occupancy. In conclusion, the AMORE project was not found to be cost-effective in providing mobility services for the agency, but it was found to provide users with an affordable mobility option. Due to this mix of findings, Hypothesis 7 was found to be partially supported.

Hypothesis 8: AMORE project increases carpooling among Tucson residents.

Performance Metric	Key Finding
Reported carpooling from survey and activity data (if known)	Insufficient information to evaluate this hypothesis.

There was not enough information available to evaluate this hypothesis. The survey was designed to evaluate this hypothesis; however, given the limited number of responses, Hypothesis 8 could not be evaluated and was found to be inconclusive.

Hypothesis 9: The integration of these mobility options into Metropia increases the use of RubyRide and Metropia.

Performance Metric	Key Finding
RubyRide and Metropia usage	Usage levels and available data not sufficient to evaluate this hypothesis.

As shown in Figure 4-1, activity data showed that RubyRide experienced an increase in ridership during the first months of the project. However, this usage was driven by a few high-frequency users in late 2018. Use of the service dropped off in early 2019, as a few frequent users ceased their activity. The survey was designed to support the evaluation of this hypothesis by asking respondents about how often they used AMORE services and how it impacted their use of available modes. Ultimately, the data available and the usage levels of the service were not sufficient to evaluate Hypothesis 9 and was it found to be inconclusive.

Hypothesis 10: The process of deploying the project will produce lessons learned and recommendations for future research and deployment.

Performance Metric	Key Finding
Qualitative documentation from stakeholder interviews	Project sought to deliver new mobility services to a low-density exurban environment. Service area of the project was found to be problematic due to lack of destinations within service area, which limited the utility of the project to residents within the service area, as many wanted to be taken outside the service area. Low- density areas in Tucson determined to be less ideal for project of this type due to low public transit ridership and relatively low congestion.

The evaluation team interviewed members of the AMORE project team to better understand challenges, barriers, successes, and broader lessons learned from the implementation of the project. Interviews were conducted with representatives of the Pima Association of Governments, Metropia, Sun Tran, and RubyRide. Section 5 provides a synthesis of those interviews and the findings related to Hypothesis 10.

Wait and Travel Time Comparisons of WAV and Non-WAV Trips

During the demonstration period of the AMORE MOD Sandbox project, there were no requests by travelers for RubyRide WAVs. Consequently, an analysis comparing wait times and travel times for RubyRide WAV trips and non-WAV trips within the AMORE project could not be conducted. However, the evaluation team did conduct an analysis of wait times and travel times of RubyRide trips from the available activity data, all of which were for standard vehicles.

Figure 4-8 presents wait time in minutes for RubyRide. The results show that a significant number of RubyRide trips had wait times of zero minutes (including times when the vehicle arrived early). The proportion of RubyRide trips with zero wait time was 41%, followed by trips with wait times of 2 minutes, the median of all wait times. The average wait time (excluding erroneous outliers) was 3 minutes. A minority of wait times was significantly larger than the median and average, with about 10% of wait times spanning 10 minutes or more. Overall however, RubyRide generally delivered wait times that were reasonable and competitive with fixed-route transit headways.

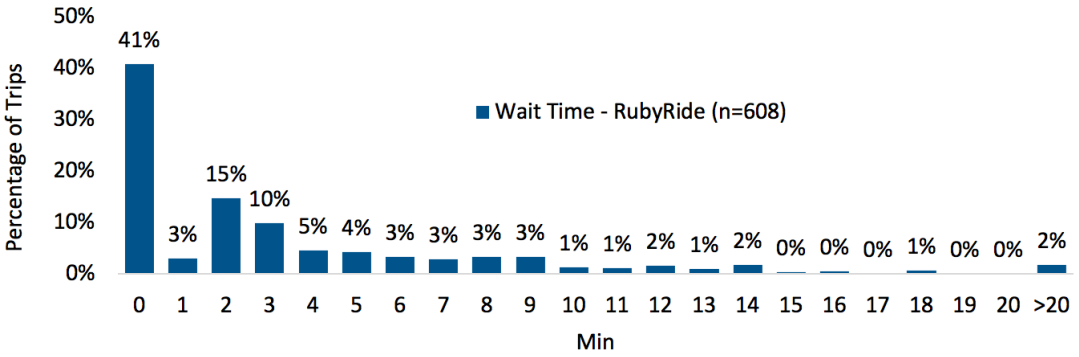

Figure 4-8 *Wait Times for RubyRide, October 2018–May 2019*

Figure 4-9 presents in-vehicle travel time (in minutes) as a percentage of trips. A high proportion of RubyRide trips had travel times over 15 minutes, including about 3% of trips over 30 minutes. The median travel time was 12 minutes, and the average was 13 minutes. The distribution shows a bi-modal distribution, where a certain concentration of travel times were between 4 and 10 minutes, and another concentration of travel times were between 14 and 21 minutes. This suggests a bifurcation of destinations, where some trips required travel to a specific area that was further away from another commonly-requested (and closer) destination. It should be noted that the RubyRide activity data did include some measurement error, where specific trips were noted as being exceptionally long in time. This could occur if the driver forgot to "end the trip" via their smartphone. Outliers that could be easily identified were extracted, but others that might have been subject to a less noticeable error (such as by 5–10 minutes) could have been retained.

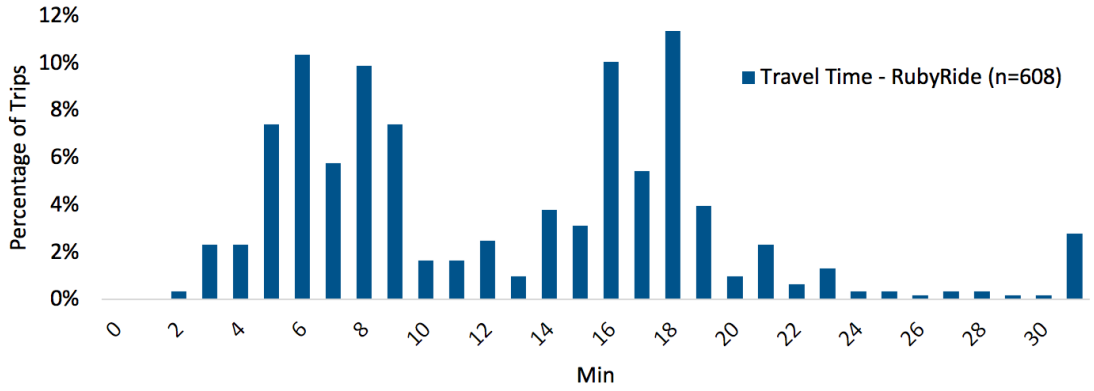

Figure 4-9 *Travel Times for RubyRide, October 2018–May 2019*

Overall, RubyRide had wait times that were concentrated at zero minutes, with a median of 2 minutes and an average of 3 minutes. Vehicles regularly (~ 41% of trips) arrived early, with the vehicle present before the requested pickup time. Travel times with RubyRide exhibited a bi-modal distribution, with a median of 12 and average of 13 minutes.

Section 5

Lessons Learned from Project Partners

Project Conception

When the MOD Sandbox program was announced by FTA, the Pima Association of Governments (PAG) was initially approached by Metropia and introduced to RubyRide, which was looking for a MOD Sandbox partner. PAG had a longstanding relationship with Metropia on a number of other projects related to commute trip reduction and traveler data. Around the same time, RTA was looking to leverage federal funds to augment services through neighborhood circulators and other strategies that could increase ridership and level of service. RTA had initial discussions with a number of stakeholders about who would be the lead project applicant (e.g., Sun Tran vs. another partner).

These discussions led to the development of the AMORE project, which envisioned enhancing mobility access and reducing vehicle dependency by integrating the best attributes of multiple innovative mobility services and technologies. Project partners began to conceive of a pilot that augmented fixed-route transit service with an integrated, multimodal, demand-response service that could be planned, dispatched, and paid for through a single smartphone app. The AMORE project envisioned several strategies, including:

- Establishing a system of credits that can be subscribed, purchased, earned, and transferred among families and friends via a range of activities to meet the individual's mobility needs. Credits could be earned by adjusting travel behavior through shifting travel times, carpooling, or other activities conducive to reducing congestion. Credits would be redeemable via the Metropia app and used with any service available in the app, including driving, carpooling, demand-response services (via Ruby Ride), and fixed-route public transportation. It was envisioned that subsequent versions would include shared micromobility and TNCs.
- Introducing subscription demand-response transit (RubyRide) as an option for commuting and first-/last-mile service to transit with the goal of achieving higher transit usage and vehicle occupancy (e.g., reduced VMT at a lower cost than other TNC services).
- Integrating carpooling with RubyRide to create a network of on-demand, flexible route services.

Following earlier development discussions, the project partners (PAG, RTA, and others) began to focus on the greater Rita Ranch area that was served by traditional fixed-route transit. Like other low-density service areas, RTA faced numerous challenges including limited service (geographic coverage and frequency) that contributed to insufficient ridership and limited the ability to further innovate, expand coverage, and increase ridership. Based on the proposed service area, the project partners decided that it made more sense

for RTA to lead the application process. RTA had staff that lived in the proposed service area, including neighborhood contacts, and had sufficient familiarity with the area to recommend service area boundaries, connectivity to shuttles and buses, and knowledge of land uses that would be important to connect (local high school, community college, grocery store, and park-and-ride lot).

Challenges and Lessons Learned

The expert interviews conducted in August 2019 by the evaluation team revealed six key lessons learned identified during the project, including the following:

- **Service Area Selection** – As with other MOD projects involving demand-response services, developing the ideal service area represented a significant challenge. Project partners came to the realization that the service area suffered from low ridership, in part due to poor market research and lack of destinations within the service area. The service area was not selected because of demand but because the area had certain institutional attributes, such as low frequency of public transit service with limited ridership. Rather than trying to develop a service to meet an unmet mobility need, a primary goal of the service area was to design a service that replaced the existing fixed-route service.

  Over the course of the project, the project partners realized that users of the service were interested in being picked up and taken to a different part of Tucson; it became difficult to find riders interested in taking trips within the originally-conceived small service area, in part because there were no major employers or destinations within the service area. Project partners considered moving the service location and/or adding specific pick-up and drop-off points outside the service area (e.g., downtown, airport, etc.). However, RTA opted not to do this due to budget constraints and instead expanded the service area slightly to an adjacent community (Vail) to the south of Rita Ranch. However, the interviewees described this effort as "a little too late," as this service area changed occurred during the last 1–2 months of the pilot.

  The partners discussed the potential of expanding and reshaping the service area. However, what they learned was that it is difficult to expand service in an exurban and rural area. When they originally conceived of the service area, they believed the community was self-sustaining. However, what they found was that people regularly travel 10–20 miles per trip and go far outside the service area. They concluded that they should have recognized a few key warning signs at the beginning of project conception, such as the area's affluence with near ubiquitous vehicle ownership and the bedroom community nature of the service area with very low density. As such, the demographic profile of the pilot did not correspond to the demographics of most RTA riders. Similarly, the demographic profile of the

pilot did not correspond well with the typical demographic profile of TNC users, who are often younger and less auto-dependent riders working and residing in higher-density urban centers. As such, the interviewees said that public agencies should not assume that there is latent demand in the suburbs.

The interviewees also noted that Tucson may be too small for this type of use case because of its low density and sprawling built environment with relatively low levels of congestion (compared to much larger metropolitan areas). As such, the factors that typically support choice transit riders are generally non-existent in Tucson, and public transit-dependent riders generally locate in areas with existing higher frequency fixed-route service.

The project partners concluded that "if you build it, riders will not necessarily come" and that projects must align with both public agency and traveler pain points. In summary, interviewees said that AMORE did not consider the user and, therefore, suffered from a poor choice of service area that ultimately caused the service to be more expensive than the existing fixed-route service. Given that service areas are context-specific, several interviewees recommended that public agencies conduct market research and an origin-destination analysis and develop a decision-making process to understand if an area is appropriate for certain types of MOD projects.

- **Labor** – The AMORE project highlights a key trade-off between the cost and reliability of MOD partnerships in low-density and off-peak service environments. TNC service in lower-density and rural areas often is unreliable and has a high likelihood that no drivers will be available. To overcome this challenge, contractors have to be provided with guaranteed hours to make it worthwhile for drivers to be on standby. However, paying for idle drivers creates a high fixed operational cost in spite of offering better reliability. To overcome potential reliability challenges, RTA hired drivers and paid them an hourly wage ($12 per hour), which kept a certain number of drivers on-call but led to the depletion of funds more quickly than if drivers had been dispatched and paid on a per-trip model.
- **Insurance** – Insurance was a notable challenge that delayed the project and almost prevented it from getting off the ground. The project partners found that insurance companies were not willing to insure the TNC model because drivers were using their own vehicle. It was eventually decided to work with an insurance provider that required ZenDrive, a third-party application that uses smartphone sensors and algorithms to predict risk, and to share these data with the insurance provider. ZenDrive integration represented a notable challenge for RTA and delayed the development timeline because Metropia had to build an API to connect with ZenDrive. The project partners described numerous technical and fiscal challenges

over a six-month period of developing the API and working with ZenDrive, whose programmers were based overseas.

- **Marketing** – The project partners realized that marketing AMORE was key and that the public has preconceived notions about TNCs that had to be overcome through education and outreach. Therefore, the project developed a community engagement strategy that included marketing, helping on-board users to the pilot program, and forming liaisons between drivers and the technology team to assist with the development of in-app communications and training documents. Because much marketing was channeled through project stakeholders, the interviewees also noted the importance of diversifying stakeholder outreach and not conducting all marketing and outreach through a single stakeholder. The interviewees expressed the importance of marketing flexibility using a range of media including newsletters, flyers, press releases, stories in local newspapers, and targeted social media advertising. However, it was quickly learned that due to the small geographic area and population size, targeted geographic marketing could not be conducted as part of a digital media campaign.
- **WAVs** – RubyRide believed that it could purchase a WAV and be reimbursed by RTA, but quickly learned it required the proper procurement process. Instead, a third party ended up purchasing the vehicle and leasing it to RubyRide and adding a vehicle wrap for branding. Additionally, it was believed that there would be WAV trip requests; in hindsight it was believed that no requests for RubyRide WAVs was probably likely due to users using SunVan, the local paratransit provider with which they were already familiar.
- **Technical Challenges, including Onboarding Process** – Interviewees described several small technical challenges in the early roll-out of the pilot, such as trips that were dispatched and dropped from the system and other challenges specific to the Android version of the app. They also expressed the importance of closely monitoring the service area map to ensure proper geocoding so users can drop a pin or enter an address at all desired destinations within the service area. Additionally, due to the pre-registration requirement of the pilot, the app could not be downloaded from the app store, which required technical assistance from Metropia. Finally, during the on-boarding process, users were asked if they had a credit/debit card and smartphone access; those who needed a credit/debit card were encouraged to purchase a Visa gift card and use a feature available to allow them to request rides (however, the latter feature was noy used by any users during the demonstration).

Concluding Recommendations

The interviewees concluded with a few additional recommendations:

- A desire for a greater cost share between FTA and the lead applicant – one private sector project partner described putting in more time and software development costs than was funded and described the MOD Sandbox as an investment decision and a "loss leader" for potential follow-on work with other public transit agencies. They attributed the demonstration to allowing their company to learn about novel technologies, partnerships, and service deployments.
- Overwhelming need for FTA to fund post-Sandbox follow-on work, including development of a public agency guide that includes a decision-tree and a process for public agencies to follow to understand if certain types of areas are appropriate for certain types of MOD projects.

Next Steps

Moving forward, the MOD Sandbox will likely have a larger impact on Pima County. It is anticipated that the software features developed for the project will also be applied to the region's paratransit program; Metropia believes that doing so would result in a 20% improvement in paratransit operational efficiency. Additionally, RTA and Sun Tran hope to take the lessons learned from the project and apply them to a bus route closer to an urban center that runs through an underserved community and connect an underserved neighborhood to nearby commercial centers and community resources. However, a key challenge will be determining how to take unbanked riders dependent on cash payment and place them into a transportation program that traditionally has been dependent on cashless payment. RTA and Sun Tran are still determining the optimum service area size, right-sizing vehicles, and how to refine the concept and community outreach for an underserved community.

Section 6

Conclusions

The AMORE project in Pima County sought to achieve a number of ambitious objectives for a mobility service within a challenging built environment context. The service ultimately wanted to deliver a cost-effective, point-to-point service within a low-density exurban environment. The evaluation aimed to explore several hypotheses related to the project performance; the analysis for some of the hypotheses was limited due to the lack of survey data from project participants. Hypotheses related to the behavioral impacts of specific demographic cohorts or use of the app ultimately could not be addressed due to lack of survey data, despite notable recruitment efforts on the part of the project team.

Activity data were used to address other hypotheses. The impact of the project on VMT was evaluated using RubyRide data alongside limited survey data on mode shift. A simulation of mode shift across the trips was implemented to evaluate the range and distribution of the likely VMT change that could have a resulted from the project. The results suggest that the project likely increased VMT, as the survey data suggest that a fair share of the RubyRide trips substituted for auto trips that would have been achieved by walking or bicycling. Even if the share of non-auto trips being substituted had been considerably lower (less than 50%), the overall results would have very likely been the same. RubyRide trips (as well as SunVan trips) were found to have considerable overlap with origins and destinations, suggesting that the services provided were roundtrip in nature. Due to this finding, it was concluded that few trips connected with other public transit services. Overall, although survey data were very limited in their capacity to evaluate behavioral changes in VMT, patterns within the activity data suggested that the possible pathways for reducing VMT through the project were not viable.

The evaluation also explored the cost-effectiveness of the project in delivering mobility services to residents of the pilot region. Using data on total project costs and available cost information for demand-response services noted in the NTD for RTA, the evaluation suggests that the system was not more cost-effective on a per-trip basis than existing on-demand or fixed-route services in the broader region. However, trips were provided at competitive and affordable costs to consumers (zero cost) and succeeded in offering additional affordable mobility options to consumers within the region. Evaluation showed favorable travel and wait times for RubyRide; wait times were particularly good, with 41% of trips involving no wait time (from requested pick-up), and travel times averaging about 13 minutes.

The pilot implementation produced several lessons learned. Most notably, the project team concluded that the service area was not ideal for a project of this type. One reason was that the exurban nature of the area was not conducive

to making connections to the broader public transit system in Tucson. Many people in the area made trips outside the MOD service region; thus, the system could not be used to complete such trips, so the system had limited utility for only specialized purposes.

Other limitations related to cost structures, where the low-density environment required drivers to be on-call and paid hourly. This led to a more rapid depletion of funds relative to paying for services on a per-trip basis. The project also faced challenges in obtaining insurance and implementing marketing of the services. A new application had to be built to connect to the insurer that agreed to underwrite the project. A more diverse marketing strategy was also determined to be needed; the marketing conducted was predominantly digital, which was suggested to be not as effective as local marketing (such as flyers, and newspapers) given the small and targeted region of implementation. Digital marketing was considered to be more viable at a larger geographic scale.

Collectively, these limitations suggest that the project encountered and attempted to overcome several unforeseen challenges associated with the geographic region of the implementation. Broadly, most hypotheses of this evaluation were inconclusive or unsupported, but the project team was able to extract and share a number of valuable lessons learned on the implementation that can inform and support the development of future projects seeking to pursue similar objectives within comparative environments.

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