New Urban Mobility Ecosystem

Fall 2017 • Management 641 Industrial Ecology

Class Reports Compilation

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UNIVERSITY OF OREGON

TRIMET

SCI Sustainable Cities Initiative

SCYP Sustainable City Year Program

Acknowledgements

The authors wish to acknowledge and thank TriMet and their Southwest Corridor partners for making this project possible. We would also like to thank the following staff who were instrumental to this project.

Jeff Owen, Senior Planner, Active Transportation, TriMet

About SCI

The Sustainable Cities Initiative (SCI) is a cross-disciplinary organization at the University of Oregon that promotes education, service, public outreach, and research on the design and development of sustainable cities. We are redefining higher education for the public good and catalyzing community change toward sustainability. Our work addresses sustainability at multiple scales and emerges from the conviction that creating the sustainable city cannot happen within any single discipline. SCI is grounded in cross-disciplinary engagement as the key strategy for improving community sustainability. Our work connects student energy, faculty experience, and community needs to produce innovative, tangible solutions for the creation of a sustainable society.

About SCYP

The Sustainable City Year Program (SCYP) is a year-long partnership between SCI and a partner in Oregon, in which students and faculty in courses from across the university collaborate with a public entity on sustainability and livability projects. SCYP faculty and students work in collaboration with staff from the partner agency through a variety of studio projects and service-learning courses to provide students with real world projects to investigate. Students bring energy, enthusiasm, and innovative approaches to difficult, persistent problems. SCYP's primary value derives from collaborations resulting in on-the-ground impact and expanded conversations for a community ready to transition to a more sustainable and livable future.

SCI Directors and Staff

Marc Schlossberg, SCI Co-Director, and Professor of Planning, Public Policy, and Management, University of Oregon

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About TriMet

The Tri-County Metropolitan Transportation District of Oregon was created by the Oregon Legislature in 1969 to operate and oversee mass transit in the Portland Metropolitan region. This public entity was formed by the legislature as a municipal corporation to replace the multiple private interest mass transit companies that previously operated in Multnomah County, Clackamas County, and Washington County; the counties that make up TriMet.

In addition to operating bus lines, light rail, and paratransit in the defined Tri-Metropolitan district, TriMet also connects to external mass transit services to provide wider blanket coverage for the region. TriMet's nationally recognized transit system provides more than 100 million rides annually, and carries 45% of rush hour commuters going into the downtown Portland area. TriMet not only moves people, but helps build sustainable cities by improving public health; creating vibrant, walkable communities; supporting economic growth; and working to enhance the region's livability.

Several civic leaders have been highlighted as key Figures in the creation, establishment, and ultimate success of TriMet. Governor Tom McCall is credited with the initial call for the creation of the public corporation; other key contributors include Congressman Earl Blumenauer, Rick Gustafson, Dick Feeney, and Mayor Neil Goldschmidt. All were instrumental in shaping the organization itself, as well as the land use, civic development, and transformation policies that make TriMet the success that it is today.

The vision and efforts of these individuals and countless others have borne fruit. Recently, TriMet celebrated the second anniversary of the opening of its most recent light rail line. Since its inauguration the 7.3-mile MAX Orange Line has experienced continued growth, having a six percent year-to-year increase in ridership. Illustrating the holistic approach that has been a part of TriMet from its inception, there have been wider community benefits such as a positive impact on employment and a focus on sustainable practices such as bio-swales, eco-roofs, a first-in-the-nation eco-track segment, solar paneling, and regenerative energy systems.

TriMet is a key partner in the region's Southwest Corridor Plan and Shared Investment Strategy. Eleven partner agencies are participating in planning for a new 12-mile light rail line in southwest Portland and southeast Washington County that will also include bicycle, pedestrian, and roadway projects to improve safety and access to light rail stations. Southwest Corridor stakeholders include Metro (the regional government), Washington County, Oregon Department of Transportation, and the cities of Beaverton, Durham, King City, Portland, Sherwood, Tigard, and Tualatin. This collaborative approach strives to align local, regional, and state policies and investments in the Corridor, and will implement and support adopted regional and local plans. These initiatives and outcomes from participation with the UO's Sustainable City Year Program will help develop ideas that are cost-effective to build and operate, provide safe and convenient access, and achieve sustainability goals while supporting the corridor's projected growth in population and employment.

Course Participants

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Urban Mobility Report Overview

Background

This project was a collaboration between the University of Oregon, TriMet, and the Sustainable Cities Initiative.

TriMet Overview

TriMet provides bus, light rail, and commuter rail services in the Portland, Oregon metropolitan area. Established in 1969, TriMet is a public agency with a service area of over 500 miles and an average daily ridership of 300,000 people. Modes of mass transit offered by TriMet include busses, light rail, and commuter rail lines. TriMet operates over 650 busses covering 77 different lines, TriMet's MAX light rail covers 60 miles of track with 145 vehicles, and the Westside Express Service (WES) commuter rail provides rush hour service to the communities of Tigard, Beaverton, Tualatin, and Wilsonville. TriMet also offers door-to-door LIFT Paratransit Service for individuals with disabilities.

UO Overview

As part of the Industrial Ecology course taught by Professor Joshua Skov at the University of Oregon, nine teams studied the future of urban transport and the potential impacts of emerging technologies and business models. Each team was tasked with investigating one aspect of transportation in an urban setting and producing a report on topics including ride-sourcing, bike sharing, app integration, customer behavior, autonomous vehicles, and privacy issues. Each report contains detailed background, analysis, and specific recommendations for TriMet. Research included literature reviews, interviews with industry experts, and business analysis. Teams also worked closely with Jeff Owens of TriMet, as well as Megan Banks from SCI, and coordinated and shared resources among teams.

Purpose

TriMet plays an integral role in the movement of people in the Portland region, directly and indirectly. Directly, the agency is a major mover of people, by bus and light rail. Indirectly, the agency has a central role in shaping the options available to metro area residents by influencing infrastructure, technology partnerships, and the built environment. As urban transport changes, TriMet will be in a position to help reshape the urban form in Portland. The goal of this report is to provide accurate, up-to-date, and relevant information on the latest trends, technologies, and best practices in order to help TriMet navigate and thrive in this dramatically-changing landscape.

Projected timelines vary, but the world is undoubtedly moving towards a future that is more connected, electrified, autonomous, and multimodal. New shared-use mobility business models like ride-sharing, ride-sourcing, and Transportation as a Service (TaaS) will upend many of the current models. Coordination with social events and activities outside of transport will offer efficiencies to the consumer. The automation of vehicles will change the way people and goods are moved from place-to-place, and the notion of personal vehicle ownership will be challenged. As personal data is collected and shared, new privacy and security concerns are arising.

Integrating these new modes, functions, and models represents both a challenge and an opportunity for TriMet. The potential exists to create an urban environment that is safe, inviting, and healthy for its citizens, improves the quality of people's lives, and is beneficial for our environment. This will be accomplished by integrating existing services (ride-hailing, bike-share, etc), utilizing current and developing technology (apps, autonomous vehicles, etc), and improving policy around mobility solutions.

Report Topics & Teams

Existing Mobility Apps & Systems

- Llyswen Berna, Aaron Bush, and Leah Elstrott
  Review of Transit and Transit-integrated Apps
- Eric Buckland, Matt Currier, and Adam Hamilton
  Review of Other Urban Mobility Apps
- Cole Peterson, Ian LeClair, Jack Strother-Blood, and Jess Whitney
  TriMet's Relationship Opportunities with Private Transportation
- Sam Chiang, Timothy Cohalan, and Jushnu Mukherjee
  Privacy and Security Issues in Urban Mobility

Transit & Shared-Use Mobility Integration

- Seth Lenaerts, Ryan Peacock, and Paoa Wandke
  Transit Partnerships with Ride-sourcing Companies
- Ted Acton, Kelsey Delagardelle, and Melena Kester
  Transit, Shared-use Mobility, and Partnerships with Bike-share Systems
- MacKenzie Blake, Michael Chisholm, Leah Goodman, and Brooke Halvorsen
  Bike-share Expansion Feasibility Framework
- Jayson Amos, Rachael Caravone, Alexis Gardner, and Alison O'Shaughnessy
  Urban Policy for Autonomous Vehicles
- Stacia Betley, Duran Brandon, Tim Gorman, and Sohee Kim
  Annotated Bibliography of Urban Mobility Consumer Behavior Research
- Benjamin Fordham and Tabit Xthona
  Report Integrators

Review of transit and transit-integrated apps

TriMet has been a leader in embracing technology and using it to create a better experience for riders. For example, it was one of the first organizations in the country to provide open-source data to programmers so they could develop new apps. It also recently installed wireless payment on buses and trains, allowing passengers to simplify their day-to-day transit experiences. It is now investigating how apps will be used in urban mobility in the future.

Transportation apps currently range from those focused on a few specific users (i.e. PDX Bus), to those aimed at giving basic navigational information to the masses (i.e. Google Maps). Trending features identified in the app comparison include event and payment integration, multimodality options, and integration with other transportation apps. Overall, we are seeing apps move towards providing more options and real-time data, as well as integrating features to simplify the transit experience. The most important efforts over the next few years will be to establish cohesive systems and experiences that link multiple functions (tickets, maps, public transit, etc.) in a single app platform. TriMet's decisions about what data to provide third party app developers as well as what partnerships to explore (i.e. whether to partner with private companies such as Lyft or Uber, or bike-sharing companies, for example) will have a significant impact on Portland transit over the next decade.

The rising number of transit apps has led to an increase in public transportation use. This has had positive economic impacts on the transit sector as well as providing environmental benefits. Using public transportation apps has also been shown to help with public health and rural transit. There are some concerns about equal access to apps, but these can be combated in several ways.

TriMet has been providing open-source data for just over a decade (starting with Google), but it is possible that it has not been collecting data from apps as effectively. There is a significant opportunity to provide standards and build partnerships that will allow TriMet to improve its services and understanding of consumer behavior. Overall, TriMet should move to support apps that integrate payment features and provide continuous service across multiple geographic locations.

Review of mobility availability apps

We assessed other urban mobility apps and their potential uses as an integrated framework for TriMet. Our research is focused on three integrative platforms: Migo, Waze, and SMART Urban Mobility. Our findings show that there are opportunities available for TriMet to provide data to third-parties that will produce a positive impact on urban mobility. While a public-to-business integration is currently viable, there are barriers to providing app integration from a business-to-business prospective. As app integration is still currently an emerging field, we expect market forces to help push cooperation between app developers in the near future.

Ride-hailing and renting options

The transportation business community has been changing rapidly over the past decade, and it is expected to continue making major advances in the near future. One CEO of a transportation software developing company believes the majority of transportation in cities will be autonomous shared vehicle platforms by as early as 2022. Due to the rapid changes, it will be crucial for public transportation to remain relevant and competitive.

Private Transportation

Transportation evolution has led to a handful of new competitors in the private transportation business environment. Today, the main private transportation models include: personally owned ride-sharing, traditional rental cars, ride-sourcing, and commercially owned ride-sharing. TriMet currently has a partnership with the ride-sharing company, Zipcar. However, we believe it is essential for TriMet to consider each transportation model and business in order to establish relationships that will cater to the needs of TriMet customers.

Recommendations

Transportation Partnerships

Establishing partnerships with companies that support last mile consumer needs is the main priority when determining which services work best with TriMet's traditional public transportation system. We believe that TriMet should consider forming partnerships with multiple transportation models in order to meet the varied needs of its customers. In addition, TriMet must form attractive partnership contracts to allow for future flexibility. These partners can include ride-sourcing companies like car2go or corporate businesses like Intel or Nike.

Park and Ride Charging Structure

Currently, TriMet does not charge for their parking spaces at Park and Ride lots. Across many of the Park and Rides, demand far exceeds supply, which allows for the possibility of implementing a charging structure. We believe TriMet should consider charging for parking spaces at the Park and Ride lots. The Los Angeles Metro recently introduced parking fees at its Park and Ride equivalents. The information gained from this parking model supports our recommendation of implementing a fee structure for Park and Ride lots.

Characterization of emerging privacy and security issues in urban mobility

Transportation network companies (TNCs), innovative public transportation, and bike-sharing programs are revolutionizing urban mobility and the transportation industry. However, this has also introduced privacy and security issues associated with ride-sourcing apps and websites. For our project, “security” refers to the safety of personal information, such as credit card information or locational data, but not physical safety or transportation safety.

The privacy policies for the three segments of urban mobility that we explored were comparatively similar, but the most interesting difference was the use of location data collected from customers. Uber had a few notorious examples of data privacy violations, including post-ride tracking, fingerprinting of devices, and Uber’s “God View.” Other issues related to the sensitive nature of personal data are both intentional and accidental data breaches, selling of customer data to third parties by companies like Streetlight Data, and public complacency regarding the amount of personal information shared willingly by individuals.

With proper privacy and security measures, urban mobility data could be used for the greater good of the community. Big data has the potential to optimize urban planning and transit routes, and has broader implications for transportation policy. Uber Movement was a very tentative and superficial first step in the direction of government mandated sharing of transportation data, but stronger policies could reveal the extent of vehicle miles traveled in cities by TNCs. These data could change public perception of the convenience of TNCs when weighed against the traffic congestion and additional emissions contributed by them. Additionally, data privacy groups like Electronic Frontier Foundation have created frameworks that could be used to evaluate the effectiveness of urban mobility policies.

Transit & Shared-Use Mobility Integration

Partnerships with ride-sourcing

TriMet, as well as other transit authorities, have struggled to adapt to the emergence of ride-sourcing companies such as Uber and Lyft. Fortunately, there are opportunities for TriMet to leverage them in a way that enhances overall ridership and quality of service. By entering into partnerships with ride-sourcing companies whereby TriMet subsidizes rides connected to fixed route high capactity transit, riders can overcome first and last mile inconvenience, paratransit service, carpooling, and quality of service in less densely populated regions while enhancing customer experience.

TriMet not only has to plan for emerging issues, they also must address implicit problems within public transit service including: frequency and ridership vs coverage and politics, access to transit, high costs of paratransit, and decreased or discontinued late night, early morning, and weekend service when TNC use is at its highest.

Partnerships with bike-share systems

Bike-sharing is a growing industry. Low cost, easy-to-use transportation options have increased its popularity. As bike-sharing may be the next big opportunity in urban mobility, integration with existing mass transit systems is an important key for greater success. The goal of integration is to build a cohesive union between existing transit systems and the current or expansion bike-sharing system (BSS).

Currently, there is a variety of bike-sharing systems across the globe that create examples for

best practices of operating procedures and metrics to assess a successful program.
General best practices include:

- 10-16 Bike-share stations for every square kilometer
- 10-30 bikes per 1,000 residents within a coverage area
- Comfortable, highly durable, attractive and practical bike options
- Easy-to-use technology
- Bike-friendly city infrastructure
- Dockless stations with geo-fence parking

Pricing and payment method integration with bike-sharing are especially important. Several key rules of thumb that are good to follow include:

- Universal payment system - a system that works across different platforms creating a greater network
- Promotions that increase ridership
- Annual and casual users
- Price lower than travelling by car
- Horizontal integration across neighboring cities

Specific cities such as Hangzhou, China; Montreal and Quebec, Canada; and Helsinki, Finland provide examples of current, successful connected bike-share and public transit systems that include integrated payment systems. These examples should be researched further for building an integrated system between TriMet and Biketown.

When considering how to implement an integrated BSS with public transit, the following metrics should be utilized for the assessment: trips per-day per-bike, the network effect, user satisfaction, ease of use, and coordination with transit.

With this information, it is recommended that TriMet extend or complement existing public transit systems through better collaboration, integration, and intermodal planning.

Bike-share expansion feasibility framework

Bike-share is rapidly expanding in major cities around the world as a favorable transportation mode among locals, tourists, and people looking for a leisure activity. Portland has joined the ranks of top bike-share programs in the United States, with their 100 stations representing the ninth-largest deployment among the 113 U.S. cities with a program. With the initial launch successful, Portland must now move towards expansion of the Biketown program in the city. Looking to industry best practices, successes in Montreal and New York City, and the failure in Seattle, variables surfaced that should be considered if Biketown is to expand successfully. These findings include accessible, safe bike lanes designed with bike stations; a station density target of 28 stations per square mile; station spacing of approximately 1,000 ft apart; outward expansion executed strategically using GSI information; connecting communities to other modes of public transit (especially in low-income areas); reliable funding including public commitment if private funding lacks, partners vested in the city; and effective marketing to the target demographics (people 24-35 years of age). Portland has the people, knowledge, and commitment to execute an expansion that makes bike-sharing a part of the urban fiber of the city.

Urban policy for autonomous vehicles

Although automation has been around since the late 1800's, sophisticated automated technology in vehicles is just beginning to come to market. However, rapid advancement is upon us. Just as private sector companies are competing for a leadership position in AV technology, governments are racing to develop innovative policies that address changes to infrastructure and revenue sources resulting from vehicle automation. The multiple levels

of automation, varying strategic approaches to executing on this technology, and possible adoption scenarios complicate things even more for legislators and government agencies.

However, Oregon is taking a leadership position in this race. To ensure automated vehicle adoption is associated with Transportation as a Service (TaaS) and multi-modal transit, they are testing pay-per-mile tax and creating tools for residents to make informed mobility decisions. To take it a step further, TriMet can review the policies of other cities to find additional opportunities. This includes existing efforts to register AV testers in Nevada, cap additional parking spaces in Zurich, and partnerships with the private sector to develop a MicroTransit system in Los Angeles.

Taking into the account the current environment, existing policies, and future implications of this technology, additional planning is necessary to prepare for this disruption. This includes creating new budgets and tax schemes that account for lost revenue resulting from electrification (which affects the gas tax) and reduced need for parking (lowering municipal parking revenue). Also, implementing policies to encourage ride-sharing and multimodal transit, such as implementing congestion tax and getting rid of parking minimums. Lastly, working with the private sector to provide seamless integration with automated vehicles and public transit. Subsidizing last mile rides and working with TaaS providers to integrate payment systems will move us toward the “best case scenario” – citizens accepting AV technology as a public service that increases opportunity for higher mobility in our cities.

Annotated bibliography of urban mobility consumer behavior research

This team compiled an annotated bibliography focusing on three main areas: the determinants of mode choice, how individuals respond to the new presence of shared-use mobility, and how mode choice changes based on different socioeconomic factors. Within these questions, some topics covered included: how incentive options play a factor in ride choice and how the negative aspect of public transportation is being lifted with the rise in shared-use mobility. The intent of this annotated bibliography is to help other groups find relevant sources for their particular topics and to strengthen their case for different mode options.

TriMet's Relationship Opportunities with Private Transportation

Team 1
Ian Le Clair • Cole Peterson
Jack Strother-Blood • Jess Whitney

Executive Summary

The transportation business community has been changing rapidly over the past decade, and it is expected to continue making major advances in the near future. One CEO of a transportation software developing company believes the majority of transportation in cities will be autonomous shared vehicle platforms by as early as 2022.[1] Due to the rapid changes, it will be crucial for public transportation to remain relevant and competitive.

Private Transportation

Transportation evolution has led to a handful of new competitors in the private transportation business environment. Today, the main private transportation models include: personally owned ride-sharing, traditional rental cars, ride-sourcing, and commercially owned ride-sharing. TriMet currently has a partnership with the ride-sharing company, Zipcar. However, we believe it is essential for TriMet to consider each transportation model and business in order to establish relationships that will cater to the needs of TriMet customers.

Recommendations

Transportation Partnerships

Establishing partnerships with companies that support last mile consumer needs is the main priority when determining which services work best with TriMet's traditional public transportation system. We believe that TriMet should consider forming partnerships with multiple transportation models in order to meet the varied needs of its customers. In addition, we recommend TriMet form attractive partnership contracts to allow for future flexibility. These partners can include ride-sourcing companies like car2go or corporate businesses like Intel or Nike.

Park and Ride Charging Structure

Currently, TriMet does not charge for their parking spaces at Park and Ride lots. Across many of the Park and Rides, demand far exceeds supply, which allows for the possibility of implementing a charging structure. We believe TriMet should consider charging for parking spaces at the Park and Ride lots. The L.A. metro service recently introduced parking fees at its Park and Ride equivalents. The information gained from this parking model supports our recommendation of implementing a fee structure for Park and Ride lots.

Personally Owned Ride-Sharing

Personally owned ride-sharing companies allow private citizens to rent their personally-owned vehicles to customers. Most companies offer renting periods by the hour or day. Technology firms have aided in connecting owners with renters, including the creation of applications for smart phones and in car locking/unlocking systems.

Turo

Turo is a car rental application where privately owned vehicles can be rented by the day. Owners of the vehicle and renters set a location for the delivery and pick up of the vehicle. Turo covers insurance for renters as part of the rental cost. One advantage of this service is that Turo offers customers access to luxury, exotic, and specialty vehicles. However, price can be somewhat prohibitive as owners set the cost of the per day rental fee. Turo is currently active in Portland.[2]

1 *Higgins, 2017*
2 *Turo, n.d.*

Getaround

Getaround is a car rental application where privately owned vehicles can be rented by the hour. Owners pay $99 (+$20 per month for the installed hardware) to have a technology package installed in their vehicles, which allows renters to unlock and lock vehicles once they have paid. Owners designate a parking location where renters can pick up and park the vehicle once they're finished. Getaround covers insurance for renters as part of the rental cost. As private owners can list almost any vehicle, there is a large variety of vehicles offered to its customers. Due to the fact that Getaround sets rental prices, owners are likely to earn less money off their vehicle. Since Getaround does not need to maintain a fleet of cars, their per hour costs are less expensive than other commercial competitors. However, the business model is not always convenient for customers because the owners designate the pick-up and parking location. Getaround is currently active in Portland.[3]

Tesla

Tesla plans to offer a ride-sharing method, but is currently not active in Portland.[4]

Competitor Analysis vs. TriMet

Turo is not a direct competitor to TriMet because the cost of renting is unreasonably high for daily commuters. Instead, customers primarily use Turo for trips outside of a urban area or for unique circumstances including renting a truck to move furniture, renting a van for a trip with large group, and renting an exotic, luxury car for leisure.

Getaround is also not a direct competitor to TriMet. While the option to use the vehicle on a per hour basis is optimal for short trips and grocery runs, the need to park the vehicle back in the starting location to end the rental makes it cost prohibitive for commuting. If a customer wanted to use Getaround for commuting, they would have to pay for the entire time they were at work. The primary uses of Getaround are similar to Zipcar. Customers use Getaround for grocery trips or to meet other short-term transportation needs.

We have included Tesla in the competitor analysis as they are not currently in this market but have future plans to do so. Tesla's plan relies on the further automation of its vehicles. Tesla would allow owners the ability to earn additional income when their vehicle is not in use. A Renter in this scenario would use an app to request a ride from/to locations. The app would search for available Tesla vehicles in the program that were currently not in use by their owners. Finally the vehicle would autonomously pick up the renter, drop them off at the specified location and return to the original parking location. If successful, this plan would be a serious competitor for TriMet because it solves a lot of customer and owner pain points such as monthly payments for the vehicle and access to additional automated transportation. The deciding factor to determine whether this would be a significant competitor to TriMet would be the cost per ride and convenience. If the cost were prohibitive for longer distance trips it could supplement in a last mile delivery method for light rail users.[5]

Traditional Car Rental Companies

Car rental companies primarily serve business travelers and personal vacationers. The primary market is comprised of short-term visitors to selected areas. Car rental companies have strong relationships with transportation hubs such as airports and train stations. The average rental duration in Oregon is 9.1 days.[6] The target customers are business professionals or tourists,

3 *Getaround, n.d.*
4 *Stumpf, 2017*
5 *Stumpf, 2017*
6 *Brown, 2013*

usually families, who want a reliable vehicle on-demand. Renting a car enables the customer to maintain temporary ownership of the car for the entire duration of their trip. They can store their own cargo inside and hold the key. However, this means that drivers are responsible for insurance, gas, and amenities like GPS. See Appendix I(a) for a pricing breakdown for common models from industry leaders.

Pricing models in the car rental industry consist of base prices, fees, taxes, and additional add-ons such as insurance, booster seats, "green" donations, or GPS. The Multnomah County car rental tax is 17%.[7] This tax is passed directly to the consumer. Often times, these consumers are tourist and business travelers who bring revenue into Multnomah County permanently by paying the tax. There are large (typically 5%) "pay-now" incentives for customers who purchase a reservation in its entirety online or over the phone. This is terrific for business travelers who have prescribed arrival/departure times, but it fails to satisfy on-demand consumers who are hesitant to commit to a multi-day reservation. For loyal travelers, many car rental companies have rewards programs to incentivize repeat reservations. Perks include free hotel stays and point-based upgrades to "adrenaline" vehicles.

Competitor Analysis vs. TriMet

Car rental companies are not in direct competition with TriMet Park and Ride locations as they serve two different customer segments. Business travelers and vacationers prefer the convenience of temporarily owning a private vehicle. Private cars allow users to store their cargo and choose their route without depending on public transportation fixed routes.

Ride-Sourcing

Ride-sourcing stems from traditional taxi transportation, and has evolved with technology to assist with sourcing, direction description, and transaction payment. Within Portland the three main ride-sourcing businesses are Uber, Lyft, and a range of traditional Taxi companies.

Uber

Uber currently offers five services to the Portland community. Other than the common economical (4 Seats), XL (6 Seats), and luxury options, Uber offers UberAssist, which provides trained assistance to seniors and disabled people. Uber also offers UberWAV, which is a wheel chair accessible vehicle with the drivers trained by the CTAA. Uber's pricing structure is primarily based on cost per minute (economical option: $0.20) and cost per mile (economical option: $1.21) combined with a base fare (economical option: $5.00). Other charges may include an airport surcharge ($2.00) and a cancellation penalty (economical option: $5.00).[8] See Appendix I(b) for a complete pricing structure.

Lyft

Lyft currently offers the three traditional ride-sourcing options. These include economical (4 Seats), plus (6 Seats), and luxury options. Lyft's pricing structure is primarily based on cost per minute (economical option: $0.20) and cost per mile (economical option: $1.15) combined with a base fare (economical option: $5.00) and a City of Portland surcharge ($0.50). Other charges may include an airport surcharge ($2.00) and a cancellation penalty (economical option: $5.00).[9] See Appendix I(b) for a complete pricing structure.

7 *Oregonian, 2009*
8 *Uber Moves Portland, n.d.*
9 *Portland Area, n.d.*

Taxis

There are over twenty different taxi companies serving the Portland area.[10] The pricing tends to vary, but all companies determine their pricing structure on a base fare, cost per minute, and cost per mile. See Appendix I(b) for a pricing structure of three of the most used taxi companies.

Competitor Analysis vs. TriMet

Ride-sourcing services are both a competitor and a complement to TriMet's traditional public transportation services. As stated by Jeff Owen from TriMet, taxis are seen as an emergency option when compared with TriMet's services. Although taxis generally come at a higher cost than Uber and Lyft they continue to compete with new ride-sourcing alternatives. In longer distance transportation, ride-sourcing costs tend to be quite expensive compared with public transportation costs due to the charging structure of time and distance. For long distance trips, some ride-sourcing companies, such as Lyft, are beginning to offer bus-like transportation (Lyft Shuttle). This service is currently only offered in San Francisco and Chicago, so the full extent of how this competition will affect public transportation is yet to be seen.[11] Additionally, when customers travel shorter distances, ride-sourcing does compete with public transportation. When the fares are below a certain amount, the opportunity to split the cost with other passengers makes the cost difference between public transportation and ride-sourcing negligible. From this basepoint, convenience to the consumer becomes a major factor.

Commercially Owned Ride-Sharing

Car sharing is a transportation model where customers can use a designated vehicle for an allotted amount of time. Unlike car rentals, car-sharing provides users with the opportunity to use cars for short durations. The two largest car-sharing programs currently in Portland include car2go and Zipcar. Each car sharing program offers different accessibility, cost, length of trips allowed, and parking options. The variation among programs allows each company to cater to different individual needs.

car2go

Access to vehicles/length of trip

Users of car2go are not required to make reservations, however the option is available for up to 30 minutes in advance. Customers identify the location of available cars through their mobile app. Once customers have unlocked the car, they can access the key and use the vehicle for up to three days. Since car2go is defined by its short-term rental model, there is a 150-mile limitation per day and a limit on how long you can use a single vehicle.[12] See Appendix I(c) for a screenshot of available cars.

Cost

car2go markets itself as a pay-by-the minute company where users are only required to pay for the time customers use the car. The absence of late fees allows customers to individualize trips and also make adjustments when needed. New users are required to pay a one-time registration fee of $5 but not monthly or yearly membership fees. Portland market users have three vehicle options. The smart vehicle rates are: $0.35/minute, $15/hour, $59/day and the

10 *Best Cab Companies in Portland Oregon, n.d.*
11 *Sen, 2017*
12 *Car2go Carsharing Portland, n.d.*

Mercedes-Benz vehicle rates are: $0.45/minute, $19/hour, $79/day. car2go users are not required to pay for fuel, insurance, or parking (within designated Home Area).[13] However, a $1 per trip fee was introduced in June 2015 to help cover the cost of reducing driver's insurance deductible.

Parking

Unlike other car rental programs, car2go allows members to leave vehicles parked on public streets within a designated zone, the "Home Area." While designated parking lots are still available, the convenience of not having to return vehicles to a particular spot allows users to complete short and one-way trips.[14] See Appendix I(c) for a screenshot of Portland's Home Area.

Major concerns

While car2go provides the benefit of pay as you go, one-way trips without the worry of gas, parking, or insurance, it also has its challenges. Many cities have been struggling with both illegal parking and unused cars taking up valuable parking spaces. In cities like New York City, parking is an extremely valuable and rare commodity. As of August 2015, car2go vehicles received 4,474 parking tickets in NYC.[15] Additionally, many residents of Portland have complained about vehicle "stacking" and that vehicles frequently occupy residential parking spots without being used for extended periods of time.[16]

Zipcar

Access to vehicles/length of trip

In order to access vehicles, members must reserve a Zipcar. Unlike other car-sharing programs, Zipcar offers the option to make a reservation through their website.[17] The need for reservations limits members' ability to extend trips if the vehicle has already been reserved by someone else. Members are limited to a rental period of up to 7 days and 180 miles per day.[18]

Cost

Zipcar requires a one-time application fee of $25, along with monthly ($7 or $125 per month) or yearly ($70 per year) membership fees associated with different plans. Depending on your ideal membership, hourly rates range from $6.86-$7.75/hour and $66.60-$74/per day in Portland.[19] When applicable, members also get charged late fees.[20] Similar to car2go, Zipcar users are not required to pay for gas or insurance.

Parking

One-way reservations are currently unavailable in Portland. Zipcars must be returned to the same parking spot. While this car-sharing service lacks the convenience of a one-way trip, Zipcar guarantees members a parking spot, and therefore, limits parking violation and hassle.

13 *Car2go Carsharing Portland, n.d.*
14 *Car2go Carsharing Portland, n.d.*
15 *Tangel, 2015*
16 *The Associated Press, 2015*
17 *How to Reserve, n.d.*
18 *Reservation Timeframes, n.d.*
19 *Portland Rates & Plans, n.d.*
20 *A Simple Guide to Successful Car Sharing, n.d*

Major concerns

While Zipcar provides the inexpensive convenience of a short-term car rental without the worry of gas, parking, or insurance, it also has its challenges. Customers find it difficult to adhere to a schedule or to plan ahead to ensure access to a car. Customers also complain about the hassle of having to return the vehicle to the same location.[21]

Competitor Analysis vs. TriMet

As it can be inferred from the information above, car sharing services are both similar and different from public transportation. At first glance, car sharing appears to be a competitor of public transportation. However, it is the similarities and differences that make car sharing complementary to public transportation.

Providing more options to commuters and residents makes TriMet more valuable. Instead of being limited by the pickup and drop-off locations, users of public transportation will be able to customize their trips to meet individualized needs. A business person from out of town can arrive in Portland via TriMet and then use a car2go or Zipcar to drive around the city to attend meetings. Residents can use car sharing services to supplement their use of public transportation when lines are out of service or to reach locations beyond the public transportation scope. If residents have more options and flexibility for transportation, they will be more inclined to use these services. In fact, 50% of Millennials surveyed by Zipcar said they would drive less if other transportation options, such as public transit and car sharing, were available in their area.[22] Additionally, "members of Zipcar and car sharing programs report a 46% increase in public transit trips, a 14% increase in bicycling trips and a 17% increase in walking trips."[23]

The momentum in car sharing is growing as cities become more congested and expensive, and as consumers demand more options. It is essential for TriMet to acknowledge and promote other forms of transportation in order to stay relevant and competitive. One excellent example is Oregon's "Zip and Ride" program that provides special rates to incentivize users.[24] Public transportation is at the heart of a personally-owned-vehicle-free future and the integration of other forms of transportation, such as car sharing, is essential for success.

Recommendations

Transportation Partners

TriMet's current partnership with Zipcar was an early adoption strategy for providing customers with additional resources for unique travel needs. Early on in Zipcar's introduction, studies showed that people who began using Zipcar also increased their use of public transportation.[25] This relationship was beneficial to TriMet, however since TriMet's initial relationship with Zipcar, the introduction of other car programs have changed what services can work best with public transportation.

Who to Partner With

Finding the most compatible partners to team up with is an important step in working with the continually evolving transportation market. TriMet's Park and Ride locations are a major hub for allowing ease of public transportation access for TriMet's consumers. Because of this benefit,

21 *Profita, C, 2015*
22 *Zipcar Overview, n.d.*
23 *Zipcar Overview, n.d.*
24 *Zipcar, ODOT and Amtrak Cascades Partner to Launch "Zip and Ride," 2016*
25 *Clendaniel, 2012*

the Park and Ride hubs will be a focal point for partner interaction with consumers. Once consumers are transported to the Park and Ride hub, the last mile to their final locations is an extremely important segment of the consumer's trip. When determining which partner to work with, it is important to identify benefits each service provides to TriMet consumers.

Car Sharing

Zipcar, which is currently working together with TriMet, is an attractive option to TriMet because of the ability for Park and Ride locations to have car sharing-specific designated spots. This drop-off location provides the consistency needed for many car sharing business models, but this is only part of what is needed for car sharing to be attractive to consumers.

For success, car sharing requires a sufficient amount of pickup and drop-off locations.[26] TriMet currently supplies pick up locations for Zipcar but since all cars need to be returned to the same location, it does not always serve consumers' last mile needs. Car2Go has circumvented the limit of a home parking spot by using a free-floating home area. Car2Go has arranged an agreement with Portland to give consumers the ability to park anywhere in the assigned home area in Portland.[27] Although this floating home area is not in the last mile high demand suburban areas like Beaverton, it may be possible to establish designated parking spots outside the Home Area region.

Even with the challenging logistics of car sharing program, it is important to integrate these services into public transportation. Car sharing will provide TriMet users with multiple options to reach their final destination or to complete different tasks in the area. Integrating both car2go and Zipcar is essential for meeting the varying needs of commuters. As described above, each company provides users with a similar and different experience. Whether it be for a quick one-way trip or for driving to meetings before returning and commuting back home, car2go and Zipcar will increase the ease of using TriMet. We suggest that designated parking spots be reserved for both car companies, however, the number of spaces allocated needs to be determined on a case-by-case basis. In instances where parking is scarce, TriMet, Zipcar and car2go could work together to locate designated parking spots for a handful of cars within walking distance of the parking lot. By creating access for community members, this would expand the reach and usage of the car sharing services, and therefore, result in fewer cars being left unused for long periods of time. Additionally, TriMet should create incentives similar to their "Zip and Ride" program where customers can use these partnerships at a discounted rate.[28]

Partner Selection

We believe the main goal of the partnership should be to provide support for TriMet customers' last mile need. Other complements to a TriMet relationship include an ability to incentivize symbiotic use, such as a discount for using both services together. Limiting partnerships to services that do not allow consumers to leave a ride at their final locations are not complementary to TriMet's transportation because it doesn't solve the last mile issue.[29] Therefore, TriMet must integrate multiple partnerships to meet a variety of customer needs. Viable options for partnerships within the transportation community include: car sharing (with designated parking spots or Home Area ranges extended to final location), transportation network companies (Uber and Lyft), and bike sharing. Transportation network companies can be used by TriMet consumers both concurrently (sharing a car with a stranger) and sequentially

26 *Taxonomy of Established and Emerging Personal Transportation Services, n.d.*
27 *Andersen, 2014*
28 *Zipcar, ODOT and Amtrak Cascades Partner to Launch "Zip and Ride," 2016*
29 *King, 2016*

(private car).[30] Bike sharing can also be a helpful tool with solving the last mile transportation challenge. Team 3 and Team 9 both research specifically on bike sharing, which will provide additional information on how bike-share can be used for the last mile concern.

Contract Suggestions

The transportation industry has been changing rapidly over the past decade, and these changes are expected to continue. When deciding which transportation services to partner with and how to structure business contracts, allowing for adjustment to new technologies and changing consumer preferences is critical.

The contract should be structured to consider the costs of last mile transport compared with our suggested Park and Ride parking costs as discussed below. This ensures a smoothly working system considering supply and demand. Discount options for TriMet users should also be incorporated into the contract. This reduces the likelihood of complete customer loss by promoting a mutually beneficial relationship between partners.

Contract Review Timeline

Attracting the most beneficial partners will require careful partner profit considerations. From the partner's perspective, the resources put into the relationship will need to yield favorable return. A favorable return from the partner's point of view will be a longer contract to help with consistency and reliability for the project return. From TriMet's perspective, the contract will need to ensure flexibility to change as the transportation services change. Generally, shorter contracts will assist with maintaining flexibility for TriMet.

We recommend that TriMet structure their contracts in one of two ways. First, they can attempt to keep their contracts as short as possible to ensure that they are providing the correct partner support to its consumers. If a partner organization is not benefitting transportation customers as anticipated, TriMet can partner with a more beneficial company. Second, TriMet can structure their contracts to include adaptability stipulations. For example, TriMet could require their partner to adopt new consumer demanded transportation types in a reasonable amount of time. This could be in the form of updating a fleet with autonomous vehicles. This will help with competition and ensure that the Park and Ride hubs are not misutilized.

Alternative Partners

By forming business partnerships with companies like Nike, Columbia, and Intel, TriMet could offer benefits to these companies in exchange for them setting up carpooling to light rail and Park and Ride locations. Both TriMet and the partnering businesses could benefit from an arrangement like this with many positive outcomes including higher ridership for TriMet and a better sustainability image for partnering businesses.

If such partnerships are attainable, we recommend that TriMet set aside specific parking spots at Park and Ride and light rail locations for these businesses. In order to coordinate carpooling, the businesses would use employee databases to determine employees living in and commuting from similar locations. After carpooling groups were established, each group would receive a hangtag for users to place in vehicles parked in designated spots.

TriMet could offer discounted prices on large group plans for the partnering businesses, and in turn could offer their employees these plans as an additional benefit of employment or at a discounted rate. MARTA in Atlanta has seen great success in partnering with companies by giving discounts on public transportation plans. They provide higher discounts rates as the number of employees signed up increases.[31] Additionally, reducing the usage of personal vehicles used for commuting would decrease the business' carbon footprint, therefore

30 *Taxonomy of Established and Emerging Personal Transportation Services, n.d.*
31 *MARTA, n.d.*

improving their public image to customers and prospective employees. This partnership would also incentivize more people to use TriMet services, and a higher density of people per vehicle parking in the Park and Ride and light rail locations would free up more room for additional users or partnerships.

Park and Ride Charging

In addition to forming business partnerships and partnerships with other transportation services, TriMet should consider charging individuals for either daily or monthly parking passes at Park and Ride locations. Monetizing parking spaces will generate revenue for TriMet and would help support costs associated with new service offerings. Pricing strategies could also help change consumer behavior towards using transportation services other than private vehicles. Other transportation companies have implemented pricing structures for individuals, most notably the L.A. Metro and Rail Line service in California.

L.A. Metro

The Metro service in Los Angeles first instituted daily paid parking at two high-traffic bus/rail stations: Atlanta on Gold Line and El Monte on Silver Line. The Atlanta and El Monte stops both charge $2 for a daily parking spot, and a $29/39 monthly fee, respectively. In the Atlantic station parking structure, there are 238 spaces available for daily use and 24 spaces available for monthly reservations. It should be noted that the Atlanta stop is at the end of a service line, so spots fill in the early morning and stay occupied until late at night. The El Monte stop serves as a hub connecting many bus and rail lines, and was expanded in 2012 to serve nearly 22,000 passengers daily, with the capacity to serve up to 40,000 passengers daily.[32] See Appendix II for a pricing breakdown at different Metro stations.[33]

Payment Methods

Apps can be used to pay fees, minimizing the impact of payment on any given user's commute. The app used by L.A. Metro is free, but there is a $0.15 fee per transaction. The penalty for non-payment is typically $50-60 depending on the station.[34]

Customer Reaction

Customer reactions to L.A. Metro's use of fee structures are mixed. Many users acknowledge that these fees support the company's ability to offer environmentally conscious travel solutions, like bus and rail services. Other users argue that the fees are simply subsidizing a corporate expansion. These consumers feel they are being charged for choosing an environmentally conscious lifestyle. Some consumers said they would not use the Metro service once fees kick in, citing concern for low-income users.[35] However, the stations that charge individuals are still popular. The L.A. Metro system used to worry about patrons taking advantage of free parking at these stations without using public transportation. Bus and Light Rail users may not have received a spot in the parking lots. Now, they can assure revenue collection from patrons who park at these stations, regardless of their use of L.A. Metro's services.

Electric Avenue - Portland

TriMet should evaluate how Portland consumers will react to a pricing model at Park and Ride locations. In order to better predict consumer behavior, we look at a similar pricing

32 Chen, 2017
33 Metro, 2016
34 Hymon, 2017
35 Linton, 2017

model on Electric Avenue in downtown Portland. Portland General Electric implemented a pricing structure for use of the electric vehicle charging stations at its World Trade Center headquarters downtown. Drivers can subscribe to monthly or daily use, with the incentive of otherwise free parking in the area. The overall pricing strategy was aimed at "offer[ing] pricing that encourages customer adoption but that also aligns with the existing charging market." The City of Portland will garner $3,000 annually from the deal, or 5% of annual revenue, whichever is greater.[36] This strategy signals an overall shift towards monetizing existing infrastructure to change consumer behavior. By reducing the overall cost of fuel and parking, PGE hopes to increase the amount of electric vehicles on the road and reward adopting consumers for their participation. As a result, the company can invest in more capital in charging stations and better position themselves in a future with an increasing number of electric vehicles.

TriMet should look to transfer the same strategy to Park and Ride locations. One key consideration that TriMet must analyze is how customers in the extended Portland area will access the Park and Ride locations. L.A. Metro realized that many commuters travel to the Park and Ride stations via bicycle. The El Monte station emphasizes free bike parking, bike lockers, and security cameras on-site. In order to maximize users per parking space, TriMet could implement secure parking options for bikes. By monetizing parking spaces, consumers may change their preferences for private vehicles towards bicycles or the aforementioned carpooling systems.

Conclusion

TriMet, and the greater public transportation sector, is facing a period of rapid technological and social change. Consumer preferences are shifting as they take advantage of new services and business models such as commercially and personally owned ride-sharing companies, traditional rental car operations, and ride-sourcing applications. TriMet can adapt to this environment through various partnerships and economic strategies. We believe TriMet can better pivot to meet consumer needs by creating contracts that allow for future flexibility. This new environment is dynamic and demand-driven, meaning TriMet cannot stay stagnant in ill-fitted contracts. In addition to forming transportation partnerships, TriMet should consider charging individuals for spaces at their Park and Ride locations. We've seen pricing strategies implemented in L.A. and their apparent success suggests the viability of this option for TriMet. With these strategies in hand, we believe TriMet is well positioned to meet future customer needs in an efficient and profitable manner.

36 Danko, 2017

Appendix

Appendix I (a):

Rental cost per day for 9-day trip (includes fees, taxes, and assumes 25+ y/o driver)

	Hertz	Budget	Enterprise	National	AVIS	Dollar	Thrifty	Alamo
Economy	$38.88	$24.68	$37.82	$52.20	$39.98	$40.27	$34.26	$37.44
Mid-size	$45.76	$37.56	$40.66	$54.51	$43.43	$40.56	$37.58	$37.71
Full-size	$52.34	$38.13	$42.30	$55.62	$59.29	$41.37	$34.98	$38.46
SUV	$52.38	$54.54	$54.86	$81.13	$55.00	N/A	$48.49	$54.81
Hybrid	$45.71	$49.08	N/A	$51.84	$51.75	N/A	$38.24	N/A

Appendix I(b):

Uber Pricing Structure:

	UberX	UberXL	UberSelect	UberAssist	UberWAV
Cancel Penalty	$5.00	$7.00	$10.00	$5.00	$5.00
Service Fee	$1.90	$2.20	$2.20	$1.90	$1.90
Cost Per Mile	$1.21	$2.01	$2.81	$1.21	$1.21
Cost Per Minute	$0.20	$0.25	$0.55	$0.20	$0.20
Base Fare	$1.25	$2.00	$6.00	$1.25	$1.25
Minimum Fare	$6.90	$7.85	$10.85	$6.90	$6.90
Airport Fees	$2.00	$2.00	$2.00	$2.00	$2.00

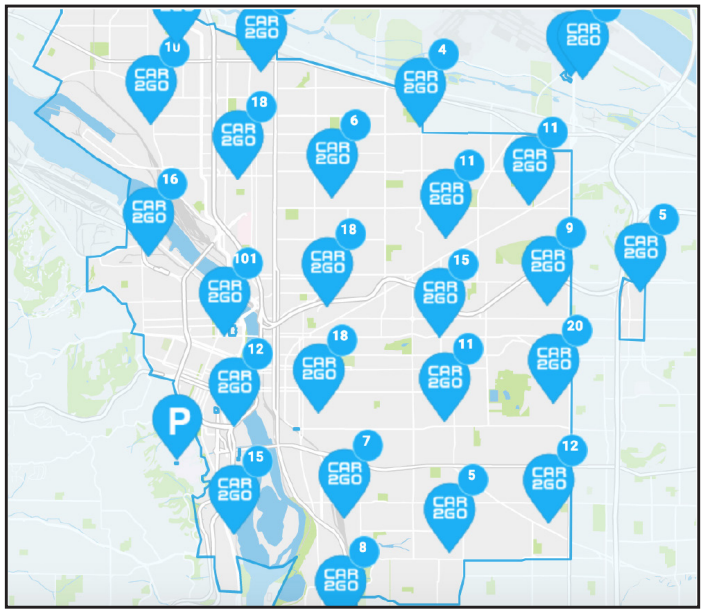
Lyft Pricing Structure:

Minimum Fare	$5.00	$5.65	$8.65
City of Portland Surcharge	$0.50	$0.50	$0.50
Airport Fees	$2.00	$2.00	$2.00

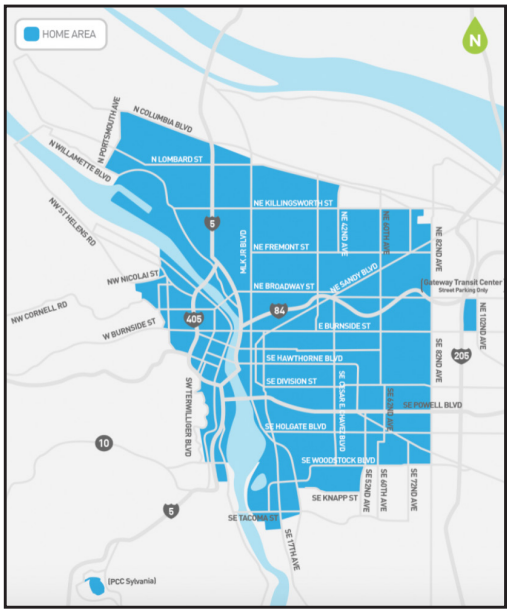
Largest Portland Taxi Companies' Pricing Structure:

	Portland Taxi Company	Broadway Cab	Radio Cab
Cost Per Mile	$2.90	$2.60	$2.60
Cost Per Minute	$0.67	$0.50	$0.50
Base Fare	$5.00	$5.00	$3.00
Minimum Fare	$5.00	$5.00	$3.00
Airport Fees	$2.50	$2.50	$2.50
Cost per Additional Passenger	$1	$1	$1

Appendix I(c):



Car2go mobile application screenshot.



Car2go Home Area.

Appendix II: Park and Ride Charging Structure
L.A. Metro Parking Management Pilot Program Pricing Schedule

Station	Rail Line	Transit User Daily Rate	Transit User Monthly Rate	Carpool Monthly Rate	# of Parking Spaces
Expo/Bundy	Expo	$3	$49	$25	214
Expo/Sepulveda	Expo	$3	$39	$25	256
17th St/SMC	Expo	$3	$59	$45	63
La Cienega/Jefferson	Expo	$3	$59	$45	485
APU/Citrus	Gold	$3	N/A	N/A	200
Irwindale	Gold	$3	$39	$25	350
Atlantic	Gold	$2	$29	$20	284
Universal	Red	$3	$55	$45	546
North Hollywood	Red	$3	$59	$45	1,310

	Lyft	Lyft Plus	Lyft Premier
Cancel Penalty	$5.00	$5.00	$10.00
Service Fee	$1.90	$2.20	$2.20
Scheduled Ride Cancel Penalty	$10.00	$10.00	$10.00
Cost Per Mile	$1.15	$1.95	$2.75
Cost Per Minute	$0.20	$0.25	$0.55
Base Fare	$1.25	$2.00	$6.00
Maximum Fare	$400.00	$400.00	$500.00

Norwalk	Green	$2	$39	$25	1,720
Lakewood	Green	$2	$39	$25	299
Aviation	Green	$3	N/A	$25	390
El Monte	Green	$2	$39	$25	1,809

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Transit Partnerships with Ride-Sourcing Companies

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Executive Summary

TriMet, as well as other transit authorities, have struggled to adapt to the emergence of ride-sourcing companies such as Uber and Lyft. Fortunately, there are opportunities for TriMet to leverage them in a way that enhances overall ridership and quality of service. By entering into a partnership with ride-sourcing companies whereby TriMet subsidizes rides, riders can overcome first and last mile inconvenience, paratransit service, carpooling, and quality of service in less densely populated regions.

TriMet not only has to plan for emerging issues, they also must address implicit problems within public transit service including: frequency vs coverage, access to transit, high costs of paratransit, and decreased or discontinued late night and early morning service.

TriMet Current Analysis

TriMet is a public agency that provides mass transit within Portland Metro. Its service area includes Multnomah, Washington, and Clackamas Counties. TriMet operates a number of transit services including: bus, light rail (MAX), commuter rail (WES), Portland streetcar, and paratransit. These services add up to a total of 77 bus lines, five light rail lines, and one commuter rail line. On an average weekday there are 246,000 originating TriMet trips.[1] In 2016, TriMet reported a total of 78 million originating rides throughout all services.[2]

Overall, TriMet ridership is decreasing,even though the overall Metro population is rising.[3] Comparing transportation modes, bus ridership has seen the most significant decreases.[4] While MAX light rail use has increased ridership, it has not kept pace with overall population growth and is below forecasted ridership.[5]

TriMet is currently exploring the causes of decreasing ridership and have put forth a number of theories, including the impacts of gentrification and the inherent displacement and immigration that comes with it.[6] The effects are multi-pronged. First, loyal transit users are being displaced by more affluent residents who use public transit less. Second, there is increasing industrial development in Portland suburbs. This means that workers who used to have jobs in the city center now require transit in more remote areas that are hard to serve.

In addition to displacement and in-city migration, the improving economy and lower gas prices are also cited as reasons for decreased ridership. Although TriMet has yet to do a study, some speculate that ride-hailing service like Uber and Lyft may also be attracting customers who would otherwise use transit.[7]

TriMet has yet to study this issue in-depth, but other communities have found that ride-sourcing services negatively impact ridership numbers. Often, ride-sourcing services are prevalent in areas where existing transit is provided. Communities around the country are struggling with ways to deal with this emerging service.

Some cities and public transit agencies are exploring ways to collaborate or even partner with ride-hailing companies as a way to increase access to transit and decrease service prices for the agency. This research project analyzed nine cities who have an agreement with ride-sourcing companies.

This research identifies ways TriMet can partner with ride-hailing services to leverage the core competencies of ride-sourcing services to reduce costs for TriMet and improve service for riders. Specifically, we are recommending TriMet look for ways to use ride-sourcing as a means

1 *TriMet, 2017*
2 *TriMet, 2017*
3 *Redden, 2017*
4 *Redden, 2017*
5 *Njust, 2016*
6 *Dowling, 2017*
7 *Redden, 2017*

of providing residents access to the existing TriMet network, augment service in low density areas, as an alternative during low service hours, and to enhance service of differently-abled passengers.

Overall Ride-Sourcing Themes and Application

TriMet serves a diverse population. A one size fits all approach doesn't work within the TriMet service area. In densely populated areas, TriMet can successfully offer high frequency transit, but outside of the Portland city core, it is difficult to do that. Although there are some high traffic corridors, much of the area outside the downtown core is not served by high frequency transit lines.

Studies have shown that frequency in service is one of the most important considerations for someone on whether or not to use transit.[8] Below, you will find how ride-sourcing themes can help TriMet meet challenges.

Our recommendations are based on research that is detailed in the section following this one. We have identified four key themes: first and last mile, shared commuting, paratransit, and transit replacement.

First and Last Mile (Appendix A)

To drive demand for buses, TriMet should seek ways to provide access to and from transit stops. In certain areas, it may be helpful to explore a first and last mile subsidy, which is defined as the distance to and from public transportation stops.[9]

Issues addressed: Decreasing ridership on bus lines, poor transit coverage, access to service and congestion.

Type of area served: low-density, poor (or no) coverage with existing transit.

Structure of Partnership: partially- or fully-subsidized rides within certain geographical bounds generally providing the subsidy for rides that start or end at transit stations. In the case of a transit replacement, TriMet would need to do a financial analysis on whether it is more cost-effective to expand coverage/increase frequency of transit trips or to subsidize rides in certain geographic areas.

Other notes: possibility for shared rides for riders originating in similar locations. In some instances companies attempted to incorporate their own app, however poor performance of these apps is cited as a pain point for customers.

Shared Commuting (Appendix B)

Shared commuting, or carpooling, can take new forms by leveraging ride-sourcing entities. Shared commuting is best integrated when a trip originates in a low density area and ends in high density or vice versa. Shared commuting can also be a tool to provide users access to the larger public transit network.

Type of area served: low density to high density or vice versa. Serving high density work areas. High frequency commuter corridors.

Structure of Partnership: per-mile payments to drivers of cars who pick up riders heading in the same direction, essentially making Lyft drivers out of regular commuters.

8 *Bliss, 2016*
9 *King, 2016*

Paratransit (Appendix C)

Paratransit accounts for the highest per rider cost to TriMet. In 2017, TriMet's per ride subsidy was $34.93.[10] Paratransit appears to be an area that ride-sourcing can be of the greatest assistance. Providing on-demand service to an underserved population is an excellent initiative to pursue.

Type of area served: all areas, areas with high incidence of elderly/disabled citizens, areas without existing handi-accessible transit infrastructure.

Structure of Partnership: similar to First-and-Last mile, but typically with a stronger subsidy and larger coverage to accommodate differently-abled riders.

Issues addressed: high capital cost of handi-accessible transit infrastructure.

Other notes: partnerships with Uber or Lyft may not be ideal, given the specific types of vehicles necessary for this partnership. Other local partners would likely be more optimal.

Transit Replacement (Appendix D)

In certain areas it may be more cost effective to use ride-sourcing as the primary source of transportation rather than expand or continue TriMet service.

Type of area served: areas with very low population density and no, or very little, existing transit infrastructure.

Structure of Partnership: subsidies that bring cost of rides down to typical public transit levels.

Issues addressed: low population density, lack of transit infrastructure, infrequent service, high initial capital and maintenance costs for public transit systems.

Other notes: this obviously doesn't apply to TriMet in a traditional sense, however it is worth weighing the cost of late night transit service against the possible subsidy costs for an Uber/Lyft partnership. The capital budgeting-style way of looking at this issue is very valuable and can be applied to any of these possible situations.

Recommendations for TriMet

The common thread among various partnerships with ride-sourcing companies like Lyft or Uber is to address issues of low coverage and commuter first/last mile. Should TriMet choose to explore the options of a public-private partnership with a ride-sourcing company, we have crafted the following recommendations based on our research.

Having analyzed TriMet's situation as well as partnerships instituted in nine other cities, we have two core recommendations: partner with ride-sourcing companies and reduce barriers to enter the current system. Each recommendation has objectives held within them, as defined below.

Partner with a Ride-Sourcing Company such as Lyft or Uber

Provide ride-sourcing subsidies for rides that begin or end at transit stations in low density areas.

TriMet should pilot this program in an area with a higher than average distance to the nearest transit stop, with a subsidy determined by the possible increase in revenue based on increased ridership from more accessibility. This can be done, at least initially, through the Uber or Lyft applications using geofences or discount codes. If the program proves successful and a more integrated system is desired, Uber and Lyft have the capability of integrating with other applications.

10 TriMet, 2017

Search for a Local Partner That Has Access to Handi-capable Vehicles to Provide a Similar Service for Differently-abled Passengers

In Centennial, a local Boulder-based nonprofit called Via was tapped to provide this service for their pilot program. If TriMet has identified demand for an increase in paratransit options, something similar would be worth exploring. Sourcing this partnership in Portland allows for a little local economic stimulation as well as a company that is more easily accountable. Low initial infrastructure should be invested until demand is ascertained, given the high cost of capital in this area and the existing incidence of handi-accessible infrastructure in TriMet transit.

Explore the Possibility of a Ride-sharing Partnership with Uber and Lyft

San Francisco partnered with Lyft to provide a carpool solution within densely populated areas. The system is set up so that customers opt-in, annotate the route they intend to take to work, and are notified of commuters going to the same area along their path. If Portland were to implement a similar program, it could relieve congestion, alleviate parking concerns within Portland, and reduce environmental impact. Since commuters plan to travel to work whether the program exists or not, the subsidies can be relatively small. This program would be most effective in areas where employees from the same company live near each other.

Reduce Barriers to Entry into the TriMet System for Customers

Develop Cross-System Payment Method

TriMet recently released their Hop Card, which can be used on TriMet, streetcars, and C-TRAN. TriMet should consider expanding this payment option for other services including bikeshare and a ride-sourcing service. Shanghai, China offers users a public metro card that works on the subway, buses, and for certain taxi companies. The city does not subsidize rides, but it does make it convenient for riders to add payment to one card that can be used on various platforms.

Market TriMet as One Mode in Your Transportation Mix

With the emergence of bikeshare and ride-sourcing services people in the TriMet area have more transportation options than ever before. Further, bikeshare and ride-sourcing are both on-demand services that make transportation easier than ever.

TriMet should promote these services to normalize non-car based transportation. For example, customers may be more willing to take a bus or carpool to work if they know they can get a cheap ride home using ride-sourcing. TriMet should consider getting passengers to consider all of their transportation options and make TriMet part of that mix.

Taking public transit may not be the most practical solution for every trip but as customers begin to build trust in alternative modes, they should inherently begin to use public transit more thereby increasing ridership and revenue for TriMet. A number of app companies are beginning to develop software that integrates transportation services. One option is for TriMet to develop a similar app, or work with companies like CityMapper to launch within the TriMet service area.

Appendix A

Case Studies of Ride-Sourcing Partnerships with Cities

Throughout our research, we found cities across the United States are wrestling with how to integrate ride-sourcing companies into currently existing public transit infrastructure. Below, we detail some of the overarching themes we found and detail plans cities have implemented in partnership with ride-sourcing companies.

One thing we noticed during our research is that there is a lack of analysis on how successful or unsuccessful these programs have been. This appears to be a combination of the fact that Uber and Lyft are relatively new and the cities have not had their partnerships implemented long enough to conduct relevant analysis.

Ideally, these themes will serve as case studies for TriMet as the agency considers what cases best serve their needs. We recognize TriMet serves a diverse area and no one case will adequately meet every requirement. However, we hope that these situations can be modified and adapted to different regions of coverage.

First and Last Mile:

First and last mile is defined as the distance to and from public transportation stops.[11] The distance of the first and last mile varies from location to location depending on population density and how far individuals are comfortable walking without assistance. This appears to be the most common theme when cities are considering how to integrate ride-sourcing into their plans.

Centennial, Colorado

Population (2016 Projected): 109,932[12]

Transit Authority: Regional Transportation District - Denver

Centennial, Colorado is a suburb of Denver located 14 miles south. The average household income is $67,000 and the average house is worth $290,800.[13] With a total population of more than 109,000, Centennial experiences heavy congestion as upwards of 44,000 citizens commute to other areas in the Denver metro area and about 53,000 commute into Centennial for work.[14]

While Centennial has a light rail station available to transport citizens around the Denver metro area, many citizens cited difficulty in getting to the station as a reason for not utilizing it. Centennial launched the Go Centennial pilot program from August 2016 to February 2017, with the intention of reducing congestion and increasing public transit ridership. The Go Centennial program had two major parts: a first/last mile partnership with Lyft to get citizens to and from the Dry Creek transit station, and a paratransit program (see Paratransit section below).

Although park-and-ride and dial-a-ride services existed in Centennial, they weren't very cost effective and citizens found them inconvenient. For comparison's sake, the Go Centennial pilot was modeled around the existing Call-n-Ride program, servicing much of the same area (around three to four square miles). The rides could only go to and from the Dry Creek Station and were completely subsidized to be competitive with the Dial-a-Ride-which cost $2.60 one way but provided free transfers to and from the light rail. Notably, the program also offered a ride-sharing option to keep vehicle miles down by picking up multiple unrelated passengers from the same area in the same car.

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11 King, 2016
12 United States Census Bureau, 2017
13 City Data, October
14 Town Charts, 2017

The program was largely successful, reducing costs-per-ride drastically and providing better service that was more responsive to demand. While many goals of the program were not met, many of them could be attributed to three things:

- Dial-a-ride services were still available, reducing ridership and preventing economies of scale.
- Technical problems with the app reduced customer satisfaction below the lofty 95% goal set by the program.
- Issues with syncing services had riders waiting longer than necessary for Lyft rides at the light rail station.

Between the severe 70-80% reduction in costs and the fact that all of the main issues can be addressed by refining the system, the Go Centennial program would likely achieve more success in full-scale operations.[15]

Columbus, Ohio

Population (2016 Projected): 860,090[16]

Transit Authority: Central Ohio Transit Authority

The City of Columbus has a median household income of $47,401 and possesses an average house value of $137,100.[17] With a population density of 3,901 people per square mile, Columbus is faced with many of the same challenges facing urban population centers as they try to streamline public transit and enhance the experience of residents.[18]

In Columbus, Ohio they are looking into subsidizing rides if they are within 3.5 miles of a transit station.[19] They anticipate that this program will cost the city $12 million and would offer up to $3 a trip to commuters who don't own a car. One potential problem of this plan is that even with subsidies the city believes it would cost $150 more per year to use ride-sourcing than owning their own vehicle. For low-income households, this cost could prove too much to bear.

Summit, New Jersey

Population (2016 Projected): 22,019[20]

Transit Authority: New Jersey Transit

Summit, New Jersey is a small town located 22 miles from downtown New York City. With one train station and bus lines, Summit residents generally work in NYC, commuting on a daily basis.[21] Optimization of transportation to and from the city in a very congested location is critical to the infrastructure and overall well-being of residents. The median household income is $132,504 and median house value is $803,075.[22]

Issues with commuters finding parking at the town's train station incentivized city officials to develop a solution. With space at a premium, the town elected to pay Uber directly and fund ride-sourcing fully for 100 commuters and offer $2 trips for all others in order to lessen the burden of parking at the train station.[23] Estimates are that the deal will cost the city $167,000 per year, compared to $10 million if they were to build additional parking.

15 *Peers, 2017*
16 *United States Census Bureau, 2017*
17 *Columbus, Ohio, 2017*
18 *Best Places, 2017*
19 *Schmitt, 2016*
20 *United States Census Bureau, 2017*
21 *Justin Kiliszek Real Estate Experts, 2017*
22 *City Data, 2017*
23 *Hawkins, 2016*

Pinellas County, Florida

Population (2016 Projected): 960,730

Transit Authority: Pinellas Suncoast Transit Authority

Pinellas County encompasses St. Petersburg, Florida and is located 24 miles from Tampa. The county has a population density of 3,351 people per square mile, median household income is $47,618 and the average house value is $170,500.[24]

This county elected to expand a small pilot program to include the entire county because of the success they had in partnering with Uber. Their program provides low-cost rides to designated bus stops.[25] Riders will pay an average of $1 to get to their nearest bus stop and then to their final destination. Ultimately, the county provides a $5 discount per trip to commuters to incentivize them. It's unclear how much the program ultimately cost the county.

Appendix B

Shared Commuting

Carpooling is one way to reduce congestion. But how do communities incentivize residents to adopt habits that benefit the larger community? San Francisco, where Lyft and Uber are headquartered, is trying to solve the city's congestion problems.

San Francisco, CA

Population (2016 Projected): 870,887[26]

Transit Authority: San Francisco County Transit Authority

San Francisco is an incredibly congested city. With over 18,400 people per square mile, public transit and ride-sourcing solutions are the best way for the population to get around without adding to the amount of cars on the road.[27] All of this makes San Francisco an ideal situation for ride-sourcing companies to introduce potential solutions and San Francisco has been working to encourage commuters to carpool. They have successfully secured a Federal Transportation Agency Mobility on Demand grant worth $521,000 to pursue this initiative.[28]

San Francisco has struggled for years with the fact that the majority of its commuters travel alone to work. In an attempt to tackle the problem, Lyft launched a carpooling service in partnership with local transportation authorities.[29] The idea is that commuters will be able to offset commuting costs without changing their current routes. The service would effectively turn everyday commuters into Lyft drivers through a separate sign-up. Any commuter who signs up for the service will be paid at the government rate of $.54 per mile, offsetting some of the costs associated with everyday commuting. Each ride would cost the city between $4 and $10, and would ideally incentivize commuters to consider carpooling over travelling alone.[30]

In the same region, the Costa County Transit Authority (CCTA) has begun to subsidize commuters who elect to use Scoop Technologies' solution.[31] The agency will pay $2 per ride, funded through an air quality tax that has been placed within the Bay Area. The challenge for CCTA is getting individuals to use the program, as a similar endeavor failed earlier. The app connects individuals who have similar starting and ending locations, commonly linking co-workers and neighbors. The hope is that the area will see a spike in the use of carpool lanes, which would indicate a trend.

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24 City Data, 2017
25 Lamela, 2016
26 United States Census Bureau, 2017
27 Moffitt, 2017
28 Mobility on Demand Sandbox, 2017
29 Lyft, 2016
30 Hawkins, Lyft Wants to Make 'Casual Carpooling' a thing again, 2016
31 Douglas, 2017

Appendix C

Paratransit

While federal laws require cities to provide transportation for disabled citizens, the service can be cost prohibitive. In an attempt to maximize limited resources and provide the best service to residents, Boston has partnered with Lyft and Uber to provide timely service to a population segment that needs it.

Boston, Massachusetts

Population (2016 Projected): 673,184[32]

Transit Authority: Massachusetts Bay Transit Authority

Boston has used a partnership with ride-sourcing companies Uber and Lyft to better serve the disabled population within the city. Currently, Boston operates a service called RIDE to transport disabled citizens. Anyone eligible for RIDE will be automatically eligible for the partnership the Massachusetts Bay Transportation Authority (MBTA) has established.[33] Prior to the partnership, RIDE serviced 5,000 daily trips to support 42,000 regular customers, who had to book their trips a day in advance.

Over five months spanning the end of 2016 and beginning of 2017, the pilot program provided 10,000 rides and gave customers the ability to book trips on demand rather than having to wait a day for the RIDE service provided by MBTA. The pilot program was created in an attempt to cut costs and it succeeded in cutting $40,000 while increasing trips by 28% because the average cost to the customer is $4.38 for the Uber and Lyft services while the Ride service costs $5.25.

More recently, the MBTA is running a pilot where passengers can ride for as low as $2.00 with Uber and Lyft, compared to $3.15 to $5.25 for RIDE service.[34] The way the pilot is set up is that customers will pay the first $1 for UberPOOL trips and anything over $41, or the first $2 for regular Uber and Lyft trips and anything over $42. MBTA pays the difference, meaning the organization can pay up to $41 a trip.

The RIDE program provided by MBTA is required under federal statute and will not go anywhere regardless of the success of the success or failure of the pilot program. One potential drawback is that to take advantage of the Uber and Lyft pilot, customers must have a smartphone to request service.

Uber has stated it would like to expand this program to other municipalities, although there doesn't appear to be any such partnerships outside Boston.

Pinellas County, Florida

Population (2016 Projected): 960,730

Transit Authority: Pinellas Suncoast Transit Authority

Pinellas County makes our case study list a second time through the use of a grant from the FTA MOD program. Pinellas County received $625,000 to subsidize a partnership with Lyft that will provide door-to-door on-demand paratransit service.[35]

The county currently provides service to over 12,500 eligible paratransit customers who request 275,000 trips per year. The grant is designed to enable the transit authority to create a centralized dispatching program that provides customers multiple transportation provider options. The county's current paratransit option costs $22.50 per ride, $6.2 million annually, comprising 10% of their budget.

32 *United States Census Bureau, 2017*
33 *Bankson, 2017*
34 *Massachussets Bay Transportation Authority, 2017*
35 *Mobility on Demand Sandbox, 2017*

The grant is projected to provide cost savings for the transit authority and increased flexibility for customers. The access to on-demand rides for paratransit riders promises to increase overall satisfaction and better integration into the overall transit network through the use of existing payment services.

Centennial, Colorado

Population (2016 Projected): 109,932[36]

Transit Authority: Regional Transportation District - Denver

Centennial is another example of a city that is taking advantage of ride-sourcing on multiple fronts. In addition to its first and last mile usage, Centennial has also partnered to better serve an underserved population.

A major feature of the Go Centennial Pilot Program was a replacement for the Access-a-Ride service, a shuttle service for people with disabilities in the Denver Metro Area. This shuttle service is expensive, costing an average of $42.96 a trip in subsidies and $4.70 a trip for the user per ride.

The paratransit portion of the Go Centennial program involved a partnership with Via, a non-profit based out of Boulder. Via ran essentially like Lyft with a handi-accessible vehicle, and ran a two-driver operation with at least one driver in operation at all times. The result of this partnership was a massive 86% reduction in costs-per-ride, completely removing the need for users to pay per ride.[37]

Appendix D

Transit Replacement

In towns or regions with low population density, the capital costs of implementing a public transit system can be prohibitive given the low utilization rates. There are some examples of locations that have opted to provide subsidies to ride-sourcing companies to provide a complete substitute to public transit.

Central Florida

Population (2016 Projected): 43,492[38]

Transit Authority: Central Florida Regional Transportation Authority

In Central Florida, transit officials have implemented a program to provide a 20% subsidy for all Uber rides that begin and end within the city limits of Altamonte, Lake Mary, Longwood, Maitland, and Sanford (established by geo-fence).[39] A 25% subsidy is given to Uber rides that begin or end at the local light rail station. Phase 2 of the pilot program will see the 20% discount extend to rides that begin and end in different cities within the program, which is intended to act as a stimulus to more economic tourism between these cities. Given that the phase 1 pilot program saw a 74% increase in Uber rides, it could be said that this program was successful in capturing a market need.[40]

Innisfil, Ontario

Innisfil, Ontario has planned a similar program with even larger subsidies. Innisfil, a town of 30,000, is providing large enough subsidies for Uber rides to make the cost to citizens equivalent to a bus ride.[41] The city is spending $125,000 to fund this program, which started May 1st, 2017, for an entire year.

36 *United States Census Bureau, 2017*
37 *Peers, 2017*
38 *United States Census Bureau, 2017*
39 *Reuters, 2016*
40 *Altamonte Springs, Florida, 2017*
41 *Pearson, 2017*

The incentive for a transit-replacement program is completely dependent on population density and a lack of infrastructure. The choice essentially came down to a capital budgeting issue: the up-front capital costs for infrastructure and the maintenance costs of said infrastructure far exceeded the regular costs of subsidizing Uber rides for a city. This does not apply to TriMet for two reasons: TriMet already exists, and the Portland metro area does not have the issue of low population density. The model of providing subsidies to increase coverage, however, is one that may find usefulness in this case.

Autonomous Vehicles

This report would be incomplete without acknowledging the aggressive efforts pursued by companies such as Lyft and Uber, who are looking to acquire the ability to transport individuals without the use of drivers. Drivers being their largest expense and the relentless pursuit of revenue will lead these companies, along with large carmakers, to develop vehicles capable of autonomous transit. (Editor's Note: Waymo has recently announced commercial TNC operations in Arizona.)

Autonomous vehicles represent a potential existential threat to transit authorities because of the potential to reduce TNC costs related to labor, and potentially lowering fares to remain competitive with transit. While there are benefits to be gained, such as fewer cars on the road and the mitigation of human error, adoption will permanently disrupt public transit if there is ease of use and the price is low enough.

There is growing research that indicates that by 2030, autonomous vehicles will be an everyday reality for cities across the United States and developed world.[42] The growth of this technology has the potential to lower costs for families, the number of cars on the road, while increasing the number of miles traveled by individual vehicles.

Adoption of autonomous vehicles will be accelerated because of the productivity gains as commuters are able to do work while traveling. The overall benefit of autonomous vehicles is predicated on the rise of electric vehicles as well as a small number of companies who own large fleets that operate in cities and regions.

We feel that autonomous vehicles are outside the scope of our current project with TriMet, but felt it is a trend that the organization should be aware of and keep an eye on in the coming years.

42 *Airbib & Seba, 2017*

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Transit, Shared-use Mobility, and Partnerships with Bike-share Systems

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Executive Summary

Bike-sharing is a growing industry. Low cost, easy-to-use transportation options have increased its popularity. Bike-sharing may be the next big opportunity in urban mobility, so integration with existing mass transit systems is an important key for greater success. The goal of integration is to build a cohesive union between existing transit systems and the current or expansion bike-sharing system (BSS).

Currently, there are a variety of BSSs across the globe that create examples for best practices of operating procedures and metrics to assess a successful program. General best practices of bike-sharing systems include:

- 10-16 bike-share stations per square kilometer
- 10-30 bikes per 1,000 residents within a coverage area
- Have comfortable, highly durable, attractive and practical bike options
- Ensure easy to use technology
- Establish bike-friendly city infrastructure
- Incorporate dockless stations with geo-fence parking

Pricing and payment method integration with bike-sharing are especially important. Several key rules of thumb include:

- Implement a universal payment system (a system that works across different platforms creating a greater network)
- Implement promotions that increase ridership
- Consider both annual and casual users
- Price lower than travelling by car
- Consider horizontal integration across neighboring cities
- Incorporate mobile

Specific cities such as Hangzhou, China; Montreal and Quebec, Canada; and Helsinki, Finland provide examples of current, successful connected bike-share and public transit systems that include integrated payment systems. These examples should be researched further for building an integrated system between TriMet and Biketown.

When considering how to implement an integrated BSS with public transit, the following metrics should be utilized for the assessment:

- Trips per day per bike
- The Network Effect
- User satisfaction
- Ease of use
- Coordination with transit

With this information, it is recommended that TriMet extend or complement existing public transit systems through better collaboration, integration, and intermodal planning.

Best Practices

When looking at bike-share systems (BSS) as they relate to shared mobility, there are some best practices for implementation to ensure the greatest success. The most important best practices are highlighted as follows:

Station Density

Having adequate bike stations located near a train or bus stop for the convenience of users is important. It is recommended for there to be 10-16 bike-share stations for every square kilometer.[1] This will provide an average spacing of approximately 300 meters between stations and a convenient walking distance from each station to a bus stop or train stop. A uniform station density throughout the coverage area of a BSS creates an advantageous, more reliable network because users can easily and conveniently bike and park anywhere in that area. If possible, stations should be located along bike lanes or on streets that are safe and accessible for bikes, and located on or near corners so that users can have more access points from different directions.[2]

Coverage Area

Bike-share coverage area must be sufficient enough to serve highly dense areas, given the large number of residents in the system. Portland has a population density (amount of residents per area occupied)[3] of 4,740,[4] which is half the density of Seattle and seven times lesser than the density of New York City.[5] Generally, a coverage area includes a 500 meter radius around each bike-share station located on the edge of the area.[6] A more specific area size can be determined by multiplying the system coverage area by the number of residents per kilometer in that area. Specific calculations for coverage areas, result in more accurate and necessary planning.[7] The minimum coverage area should be at least 10 square kilometers. Smaller areas may drive down usage and too large of areas could be wasteful, as there won't be enough residents to fully utilize the number of bikes supplied to the area.

Bikes per Station

There must be an adequate number of bikes per resident in a coverage area. Generally, it is recommended that there should be 10-30 bikes for every 1,000 residents in a coverage area.[8] Initial demand will have to be determined to better estimate the station size. Once demand is determined, the station size will then be the number of bikes per station multiplied by the docking-space-per-bike ratio to determine the number of docking spaces at each station. For example, if the docking-spaces-per-bike ratio is 1.7 docking spaces per bike, a station that needs ten bikes will need seventeen docking spaces.[9] This estimate does not take into account the 9.1 million visitors Portland welcomed in 2016,[10] and the number of tourists visiting the

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1 Gauthier, Aimee, Hughes, Colin, Kost, Christopher, Li, Shanshan, Linke, Clarisse, Lotshaw, Mason, Jacob, Par do, Carlosfelipe, Rasore, Rasore, Schroeder, Bradley, Stephanie, Treviño, Xavier.
The Bike-share Planning Guide. Institute for Transportation & Development Policy.
2 Ibid.
3 Hunter, Nancee. Calculating Population Density. National Geographic. https://www.nationalgeographic.org/activity/calculating-population-density/
4 Susim, Jason. How Does Portland's Population Density Compare to Other Major Cities? Willamette Week. http://www.wweek.com/culture/2017/03/09/how-does-portlands-population-density-compare-to-other-major-cities/
5 https://www.sparefoot.com/self-storage/blog/visualizing-portlands-population-density/
6 Gauthier, Aimee, Hughes, Colin, Kost, Christopher, Li, Shanshan, Linke, Clarisse, Lotshaw, Mason, Jacob, Pardo, Carlosfelipe, Rasore, Rasore, Schroeder, Bradley, Stephanie, Treviño, Xavier.
The Bike-share Planning Guide. Institute for Transportation & Development Policy.
7 Ibid.
8 Ibid.
9 Ibid.
10 Visitor Statistics & Research. Travel Portland. https://www.travelportland.com/about-us/visitor-statistics-research/

city that varies daily. While further data collection is suggested to account for varying tourism numbers, dockless bike stations can help mitigate some of the risk of wrongly sizing stations as it is easier to add or remove docking spaces once the system opens. Dockless bike systems will be further discussed in detail below.

Quality and Features of Bikes

Customers tend to gravitate towards comfortable, highly durable, attractive, and practical bicycles.[11] Since most bikes in a system are the same size, it might be helpful for TriMet to determine the average user height and choose bike sizes according to that information. Highly durable bikes require less maintenance and have fewer breakdowns between trips. A bike should ideally be able to handles six to nine uses a day.[12] Practical features like a front basket, would entice users to use bikes for grocery shopping orother activities that involve carrying a bag or purse. With extra storage, users would be able to utilize bike-share after going to the grocery store by train or bus.

The design of the bike will also help combat theft and vandalism. It is necessary for bike-shares to have components and locks with proprietary tooling that make it difficult to remove and to resell the components.[13] Safety is also very important, so the color of the bike, reflectors, bells, and lights for night riding must be considered, and must meet local laws concerning bike safety.[14] Being able to use the bike-share system at any time of the day will help with the timing of bus routes and train schedules.

In the future, TriMet could consider adding different types of bikes that would serve alternate functions for users, such as bikes for large purchases, electric-assist bikes, and bikes for children.[15] The feasibility of such investments should be evaluated carefully because of the requirement of additional capital investment. Although some of the special features would attract users with different needs, market research should be performed to determine if demand for special types of bikes would be worth the offering.

Easy-to-use Stations

The process of checking out a bike should be simple. The payment and authorization technology utilized should have an easy-to-use interface, a fully automated locking system, and real-time monitoring of occupancy rates to track whether more or fewer bikes are needed for each station.[16] A fully automated locking system would help new customers that have only used buses or trains, to easily learn to use a new BSS, encouraging more cross use of every transit system.[17]

Payment Methods

Having a single payment system for all modes of transportation will make it convenient for users. This integration could be enabled by having a reloadable smart card to pay for a bike and for the MAX Light Rail altogether. This universal card could be reloadable online or at every bus, train, or bike station. Integrating the pricing among each mode would also help commuters better understand how each trip could be more cost effective. A few examples of single payment systems are in Hangzhou, Guangzhou, Montreal, and Helsinki, which will be

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11 Gauthier, Aimee, Hughes, Colin, Kost, Christopher, Li, Shanshan, Linke, Clarisse, Lotshaw, Mason, Jacob, Pardo, Carlosfelipe, Rasore, Rasore, Schroeder, Bradley, Stephanie, Treviño, Xavier. The Bike-share Planning Guide. Institute for Transportation & Development Policy.
12 Ibid.
13 Ibid.
14 Ibid.
15 Ibid.
16 Ibid.
17 Ibid.

Bike Design Examples	
	Bikes offered in London contain mud guards and chain protectors.
	Bikes offered by Ecobici in Mexico City also has mud guards and chain protectors to protect users from dirt.
	In Washington, D.C., bikes have a completely enclosed chain, gear, and brake systems to protect customers from dirt and grease.
	The bike-share system in Medellín, Columbia offer two types of bikes, depending on station: a road bike and an off-road bike.
	Shanghai's tires are specialyl-made to fit the terrain in the city.

Examples of good bike designs from cities around the world
Source: Institute for Transportation & Development Policy.

outlined in detail below. The pricing structure and promotions will also be further discussed in the pricing section.

Infrastructure and Operations

We recommend having a few, major multimodal hubs with stops for all modes of transportation.[18] Downtown Portland, where the major tourist attractions are located, would be a prime location. This area would need to have a large amount of bikes at stations, and a central bus stop station from where many of the bus lines originate. This hub should also be in close proximity to the MAX Light Rail station.

The infrastructure of the city should be able to accommodate bikes by having dedicated paved bike lanes. These lanes are critical to the connecting of each mode of transportation.[19] For example, a bike station that has clear marked paths leading to either a bus stop or a MAX light rail station will make it easy for commuters to transfer between modes. To ensure ease of use for bus riders, city buses could accommodate more bike racks. Pairing the construction of new bicycle lanes with the opening of a BSS can add to public acceptance and improve safety for users of the system.[20]

Dockless Stations

Dockless stations do not require intensive infrastructure work such as excavation and trenching, which helps save costs on any type of capital investments and the amount of time to implement.[21] To ensure customers don't return the bikes to random places and create clutter along sidewalks and roadways, it is possible to have some sort of geo-fenced parking. This will help cut down the clutter associated with dockless bike-share such as seen in China and elsewhere.[22] Geo-fenced stations are easily movable, so the location of the stations can be optimized, and better placed at areas with high demand.[23] The best geo-fence locations and hot spots can be determined with data from bike usage. With Portland's weather pattern, it is beneficial to have movable stations to adapt to the colder weather in the winter and the rain from October to May.[24] Dockless BSS are complementary to the docked programs, since they aren't limited to areas where docks are installed and can scale up or down quickly to meet changing demand.[25]

New Bike Technology

Bike technology is key to the success of a system. Having an accurate GPS tracker for bikes will help people transfer easily to bikes after getting off a bus or train. Bikes should also have a wireless tracking system, such as radio-frequency identification devices (RFIDs), that locates where a bike is picked up and returned, and helps a customer to locate an unoccupied bike in their area.[26] Locking technology could include built-in, U-locks that hold magnetically to the frame that only unlock with a scan of payment.

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18 Griffin, Greg Phillip, Sener, Ipek Nese. Planning for Bike-share Connectivity to Rail Transit. Texas A&M Transportation Institute. 2017 January 1.
19 Ibid.
20 Gauthier, Aimee, Hughes, Colin, Kost, Christopher, Li, Shanshan, Linke, Clarisse, Lotshaw, Mason, Jacob, Pardo, Carlosfelipe, Rasore, Rasore, Schroeder, Bradley, Stephanie, Treviño, Xavier. The Bike-share Planning Guide. Institute for Transportation & Development Policy.
21 Ibid.
22 Heining, Andrew. We tried all four of D.C.'s dockless bike-share systems. Here's our review. Washington Post. https://www.washingtonpost.com/news/dr-gridlock/wp/2017/09/22/we-rode-all-four-of-d-c-s-dockless-bike-share-so-you-wouldnt-have-to/?utm_term=.a9fce321aa81, 2017 September 22.
23 Gauthier, Aimee, Hughes, Colin, Kost, Christopher, Li, Shanshan, Linke, Clarisse, Lotshaw, Mason, Jacob, Pardo, Carlosfelipe, Rasore, Rasore, Schroeder, Bradley, Stephanie, Treviño, Xavier. The Bike-share Planning Guide. Institute for Transportation & Development Policy.
24 Ibid.
25 Griffith, Erin. Why Investors are Betting that Bike Sharing is the Next Uber. Wired. https://www.wired.com/story/why-investors-are-betting-that-bike-sharing-is-the-next-uber/. 2017 October 16.
26 Gauthier, Aimee, Hughes, Colin, Kost, Christopher, Li, Shanshan, Linke, Clarisse, Lotshaw, Mason, Jacob, Pardo, Carlosfelipe, Rasore, Rasore, Schroeder, Bradley, Stephanie, Treviño, Xavier.
The Bike-share Planning Guide. Institute for Transportation & Development Policy.

Payment Connectivity

Bike-share pricing and payment methods vary according to the city and system. The use of new universal and connected payment methods are growing and have shown immediate success. The following includes information regarding various payment and pricing methods for bike-share in Portland to consider.

Universal Payment Methods

Bike-share payment methods vary from online or mobile credit card payments,[27] to RFID cards and key fobs for members.[28] Additionally, leading bike-share programs, such as those in Guangzhou, Hangzhou,[29] and Helsinki,[30] have successfully introduced universal payment methods that are compatible with public transportation. For example, Hangzhou has a universal card that is used for the bus, metro, and bike-share, which has increased bike and bus ridership since its inception.[31] Additional information for this system is below.

Following the international example, Los Angeles Metro Bike launched in 2016, as one of the first, domestic bike-share programs to integrate fares with public transportation. Customers register their transit fare cards online, to be used for payment for Metro Bike.[32] Transit Access Passes are connected with 24 different transit agencies in Los Angeles County,[33] increasing convenience for residents.

Aside from large scale integration in Los Angeles, payment integration with local organizations can also be successful in smaller communities. In Fargo, North Dakota, Great Rides, operated by BCycle, has a higher percentage of usage per bike than in New York, Paris, or Washington D.C. Partnership with the local university links memberships with student fees, and students use their ID cards to check-out bicycles.[34]

There is also a trend towards payment with smartphones. The CEO of Motivate, one of the largest bike-share operators in the country, predicts a migration from smart cards, like LA Transit Access Passes, towards smartphones.[35]

Membership Connectivity between Cities

In addition to simplifying payment methods between modes of public transportation, horizontal integration across cities is also trending with large bike-share operators. For example, BCycle allows annual members to use their smartphone or membership card in over 30 cities.[36] Jay Walder, the CEO of Motivate, defines the future of bike-share as more connectivity within cities and across the nation.[37] Being part of a network of comparable cities could provide opportunity to increase ridership.

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27 Margolis, Jason. Seattle becomes first US city to try dockless bike sharing, the system that's transforming China. PRI. https://www.pri.org/stories/2017-08-21/seattle-becomes-first-us-city-try-dockless-bike-sharing-system-s-transforming. 2017, August 21.
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31 Anderson, Michael. Helsinki bike-share teamed with transit and ridership boomed instantly. Better Bike-share Partnership. http://betterbikeshare.org/2016/07/11/helsinkis-instant-bike-share-boom-shows-potential-integrating-transit/. 2017.
32 Metro Bike-share - Los Angeles. Bicycle Transit Systems. http://www.bicycletransit.com/los-angeles/.
33 What's TAP? TAP. https://www.taptogo.net/articles/en_US/Website_content/about-tap.
34 FAQs. Great Rides Bike-share. https://greatrides.bcycle.com/faqs. 2016.
35 Leber, Jessica. The Future of Bike Sharing: Becoming Part of Public Transit. FastCompany. https://www.fastcompany.com/3040950/the-future-of-bike-sharing-becoming-part-of-public-transit. 2015, January 15.
36 We've Added Some Character(s). BCycle. https://www.bcycle.com/fun. 2015.
37 Leber, Jessica. The Future of Bike Sharing: Becoming Part of Public Transit. FastCompany. https://www.fastcompany.com/3040950/the-future-of-bike-sharing-becoming-part-of-public-transit. 2015, January 15.

Payment and Security

Payment methods can also guard against bike theft through user identification and fees. If the bike is not returned or is damaged, additional fees may be charged. Similar to Biketown,[38] many bike-share programs charge lost bike fees. Additionally, some programs impose deposits that can later be refunded to the associated account or card.[39]

There is additional concern for user accountability when payments are made with cash, and programs that accept cash require users to register for a membership. They can then make payments at local offices or partnered retailers, such as 7-Eleven.[40] When considering integrated payment methods for Metro Bike, Los Angeles limited integration to TAP cards that are linked to a credit card.[41] Registration or an associated account allows bike-share programs to recover the cost of a lost or stolen bike.

Pricing

There are a variety of pricing schemes for bike-share used around the world, which aim not only to maximize revenue, but to maximize ridership. For example, the city of Hangzhou offers the first hour of a ride free for members who just got off the bus.[42] Although steep discounts to incentivize use of public transportation does not maximize revenue, integration of pricing has helped to make Hangzhou one of the largest bike-share systems in the world.[43]

Pricing: Casual vs. Annual Users

In most bike-sharing systems, casual users are charged more than annual users. Research done by the Institute for Transportation and Development Policy suggests that casual users typically make up a higher percentage of bike-share revenue than annual users, because they tend to exceed initial ride time limits. After time, some casual users purchase membership passes,[44] meaning that members make up a growing percent of total revenues as the program matures.

Structure of Member and Nonmember Pricing

In many cities, members pay a subscription fee and receive a specified amount of free ride time per day, paying additional fees for time exceeding that threshold. One common model, as exemplified by SPIN in Seattle,[45] allows members one free 30 minute ride per day, with unused credits applying to rides over 30 minutes. Additional fees are then charged for additional ride time.

As Biketown membership charges per mile for rides over 90 minutes,[46] other programs operated by Social Bicycles provide additional options for members. For example, the bike-share in Hamilton, Ontario offers annual pricing options for 60 minutes per day or 90 minutes per day.[47] As previously mentioned, Hangzhou also offers steep discounts for riders who also

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38 Annual Membership. Biketown. https://www.Biketownpdx.com/pricing/annual-membership. 2017.
39 User Agreement for Casual Users. Citibike. https://www.citibikenyc.com/user-agreement-casual.
40 Cash Payment. Indego. https://www.rideindego.com/passes/cash-program/. 2017.
41 Cohen, Josh. Should a bike-share ride cost the same as the bus?. Next City. https://nextcity.org/daily/entry/bike-share-pricing-transit. 2016, August, 1.
42 Anderson, Michael. Helsinki bike-share teamed with transit and ridership boomed instantly. Better Bike-share Partnership. http://betterbikeshare.org/2016/07/11/helsinkis-instant-bike-share-boom-shows-potential-integrating-transit/. 2017.
43 Shaheen, Susan. Et. al. China's Hangzhou Public Bicycle. PSU. http://citeseerx.ist.psu.edu/viewdoc/download?-doi=10.1.1.1006.3469&rep=rep1&type=pdf. 2011.
44 Gauthier, Aimee, Hughes, Colin, Kost, Christopher, Li, Shanshan, Linke, Clarisse, Lotshaw, Mason, Jacob, Pardo, Carlosfelipe, Rasore, Rasore, Schroeder, Bradley, Stephanie, Treviño, Xavier. The Bike-share Planning Guide. nstitute for Transportation & Development Policy.
45 Spin Unlimited. Spin. https://www.spin.pm/unlimited. 2017.
46 Annual Membership. Biketown. https://www.Biketownpdx.com/pricing/annual-membership. 2017.
47 Hamilton Bike-share. Social Bicycles. https://hamilton.socialbicycles.com/.

use public transportation.[48] Variation in unlimited membership pricing could be adapted to fit the lifestyle of local residents, and can encourage the use of public transportation.

For casual users, the cost of a ride is often determined in 30 minute increments. For example, SPIN in Seattle charges $1 per 30 minutes for non-members. Other companies, such as CitiBike, also offer day passes or multiple day passes.[49] In the future, connectivity between cities may change the landscape of casual versus annual users, as bike-shares become interconnected. Some of the examples discussed are listed below:

	Hangzhou	SPIN Seattle	LA Metro
Annual Users	-First hour free -Second hour 1¥ ($0.15) -Third hour 2¥ ($0.30) -Fourth hour 3¥ ($0.44)	-$30/month or $100/year -First 30 minutes free -Additional 30 minutes $1	$7/day, $20/month -First 30 minutes free -Additional 30 minutes $1.75
Casual Users	No casual user pricing available	$1 per 30 minutes	$3.50 per 30 minutes
Other Fees	200¥ ($30) deposit for bike-share use	No other fees specified	No other fees specified
Other Promotions	No additional promotions specified	SPIN for business	Bike-share for business
Integration with Public Transit	-10% discount for taking the bus	No integration	-Flex pass $40/year to use TAP card

Pricing Promotions

To encourage ridership, many bike-share programs offer promotions. As LA Metro is currently expanding, they are offering a month of free rides in new areas, discounted rates on Tuesdays,[50] and half-off promotions that strengthened ridership.[51] Other bike-shares also offer student rates or corporate memberships,[52] as well as the first part of a ride free.[53]

Price Comparability to Public Transit and Other Bike-share Programs

Although little research has been done regarding price elasticity of bike-sharing,[54] most cities try to keep prices lower than the cost of driving or using public transportation. Steve Hoyt-McBeth, senior manager of the Portland Bureau of Transportation states: “If you’re a person who just missed their bus and needs to get across town or realized the walk to their next meeting is a little farther, a $7 pass is not a compelling use case.”[55] Other feasibility studies also consider using a “per ride” trip fee that is priced similar to public transit,[56] to improve accessibility for lower socioeconomic populations.

It is also important to consider pricing relative to existing bike-shares. In some cities, such as Barcelona, the city BSS is for annual members only, to avoid competition with other

48 Anderson, Michael. Helsinki bike-share teamed with transit and ridership boomed instantly. Better Bike-share Partnership. http://betterbikeshare.org/2016/07/11/helsinkis-instant-bike-share-boom-shows-potential-integrating-transit/. 2017.
49 Kiosk Instructions. Citibike. https://www.citibikenyc.com/pricing/day/kiosk-instructions.
50 Special Offers. Metro Bikeshare. https://bikeshare.metro.net/.
51 Looking at Downtown Bike-share, One Year Later. DT News. 2017, July 10.
52 Hamilton Bike-share. Social Bicycles. https://hamilton.socialbicycles.com/.
53 User Agreement for Casual Users. Citibike. https://www.citibikenyc.com/user-agreement-casual.
54 Gauthier, Aimee, Hughes, Colin, Kost, Christopher, Li, Shanshan, Linke, Clarisse, Lotshaw, Mason, Jacob, Pardo, Carlosfelipe, Rasore, Rasore, Schroeder, Bradley, Stephanie, Treviño, Xavier.
The Bike-share Planning Guide. Institute for Transportation & Development Policy.
55 Cohen, Josh. Should a bike-share ride cost the same as the bus?. Next City. https://nextcity.org/daily/entry/bike-share-pricing-transit. 2016, August, 1.
56 Eugene Bike-share Feasibility Study. City of Eugene. https://www.eugene-or.gov/DocumentCenter/View/16761. 2014, June.

companies,[57] such as Portland's Biketown. In comparison, the other BSS in Barcelona caters more toward casual users[58] than Biketown.

Advertising or Corporate Sponsorship Pricing

Many bike-share programs are not often profitable on ridership alone.[59] Although it plays a role in profitability, we have decided not to focus on the price of advertising or corporate sponsorship, because it is independent of integration with public transit.

Examples of Integrated Public Transit and Bike-share

As mentioned previously, having an integrated system connecting a bike-share system (BSS) to public transit is an effective way to increase ridership. The following are examples of cities that have integrated their BSS with public transit.

Larger Cities

Hangzhou, China

Hangzhou is an hour train ride outside of Shanghai and one of China's seven ancient cities. It's a very large city of 6,500 mi² with a population of 9.1M people. The city holds the Grand Canal and is considered to have the best biking route in China along the West Lake.[60] Hangzhou's public transit system includes, buses, metro, public bicycle, and ferry.[61]

About Hangzhou Public Bicycle: The government run and funded Hangzhou BSS is the largest in the world. Established in 2008, it entails approximately 75,000 bikes and 3,000 docking stations, and was created to cover the last kilometer in commuters' routes from other public transit to their destination. While the system only entails a system with station docks, a dockless version is on the horizon in order to compete with other private companies that have launched in the area.[62]

Integration: The bike-share system is integrated with the public bus and parking system and utilizes the same Transportation IC card for both forms of travel. Docks are placed every few hundred meters and located close to bus stations. Users that have used their card to pay a bus fee receive the first 60 minutes free for bike-sharing riding just after.[63] To retrieve a bike, a user swipes their bus card at a station, which unlocks the bike. Payment is all incorporated into the card. Users load the card with funds and each time they utilize a bus or bike, the very reasonable fare is deducted. In 2016, the system also introduced the addition of QR code scanning within their system.

Effect: The bike-share system has a very high usage rate, which cuts fuel consumption by 100,000 tonnes a year (equivalent to around 135m litres of petrol and diesel.[64]

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57 Gauthier, Aimee, Hughes, Colin, Kost, Christopher, Li, Shanshan, Linke, Clarisse, Lotshaw, Mason, Jacob, Pardo, Carlosfelipe, Rasore, Rasore, Schroeder, Bradley, Stephanie, Treviño, Xavier. The Bike-share Planning Guide. Institute for Transportation & Development Policy.

58 About. Ajo Bike Barcelona. http://ajobikerentbarcelona.com/.

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64 Van Mead, Nick. Uber for Bikes: How Dockless Cycles Flooded China - and Are Heading Overseas. The Guardian.

Comparable Cities with Portland

Montreal

Montreal is comparable to Portland in size at 166 mi², but holds almost twice the amount of people (1.75M). As Montreal's largest city in Canada's Quebec province, it sits along the water at the convergence of the St. Lawrence and Ottawa rivers. The public transit system in Montreal consists of metro, bus, and bike.

About Montreal Bixi Bike-share: The Bixi (Bike and Taxi) BSS was first established in 2009 as the first bike sharing system in North America. After filing for bankruptcy in 2014 due to poor technology in international expansion, the City of Montreal purchased the system with a new pricing structure, new partnerships, and initiatives such as Free Bixi Sundays, with hopes of increasing ridership. Bixi now has 6,000 bikes and 540 docking stations around the city.

Integration: Bixi was integrated into the city's public transit system, STM, in August 2016[65] with help from 8D technologies, from the Motivate operator family. At Bixi stations around the city, a rider can swipe their Opus Card (for city metro and bus) at the pay station for a single bike-share ride.[66] The integration allowed for a faster and safer payment option for riders while promoting more sustainable transit and further integration. The user must pre-register online to utilize the system.

Effect: As one of the first integrated systems between bike-share and public transit in North America, the integration helped Bixi Montreal towards a record breaking year with increased ridership, active memberships and trips taken.[67] The integrated system has reduced prices for regular riders, making the service more affordable. Now as a part of the City of Montreal's network, profits from the service are given back to the city while helping to work towards Montreal's goals of a healthier population with decreased metro congestion.

Helsinki, Finland

Helsinki, the waterside community and capital of Finland, is similar to Portland in that it is considered one of the most bikeable cities in the world.[68] While a bit smaller than Portland in size, it has about the same population. It holds an extensive public transit system that includes subway, commuter trains, buses, and ferries. All public transit, including the bike-share program is integrated in a Journey Planner app implemented by the city.[69]

About Helsinki City Bikes Bike-share: Helsinki launched their City Bikes bike-share program in April 2016. Within a year, the bike-share program tripled in size due to its success. The system is owned by Helsinki City Transport, but operated jointly between Smoove of France and Moventia of Spain. There are currently about 1,400 bikes and 140 bike stations and the system is available from May to October, but not during winter.[70]

2017, March 22. https://www.theguardian.com/cities/2017/mar/22/bike-wars-dockless-china-millions-bicycles-hangzhou
65 BIXI-Montréal and STM present a pilot project for bike rental with an Opus card at certain stations starting August 1st. STM. 2017, July 13. http://www.stm.info/en/press/press-releases/2016/bixi-montreal-and-stm-present-a-pilot-project-for-bike-rental-with-an-opus-card-at-certain-stations-starting-august-1st
66 Gaultier, Sandra. 8D Technologies, part of the Motivate family, helps BIXI Montréal fully integrate transit into its bike-share system. 2017, July 21. https://www.8d.com/news/press-releases/8d-technologies-helps-bixi-montreal-fully-integrate-transit-into-its-bike-share-system/
67 2017 Record-breaking Year for Bixi Montreal. 2017, November 15. https://www.bixi.com/c/bixi/file_db/press_release.pdf_en/Communiqu-VF-15-novembre-2017-BIXI_ENGLISH.pdf
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69 Kinney, Jenn. Helsinky Treats Bike-share as another Form of Public Transit. 2016, May 27. https://nextcity.org/daily/entry/helsinki-launches-integrated-bike-share-system
70 HSL/HRT City Bikes. Accessed 2017, November 16. https://www.hsl.fi/en/citybikes

Bike-share Integration: The bike-share program is integrated with public transit in two ways, via the Journey Planner app and via the Helsinki travel smart card. Within the Journey Planner app, riders can incorporate a bike route within their public transit trip.
Bike-share Effect: With the Journey Planning app, 60% of bike-share registered users in 2016 regularly combined the bike-share with other forms of public transportation.[71]

Metrics for Assessing Coordination with Transit in Station Placement

Metrics to assess the effectiveness of bike-sharing coordination will depend upon the goal of the program in a particular location. Metrics facilitate meaningful measurement and provide a basis for effective decision making. However, a lack of publicly available station level data has precluded sufficient research that could lead to the development of analysis of bike-sharing.[72] In this section we will focus on available metrics, common misconceptions, and case studies that can be useful references when assessing bike-share performance.

Trips per Day per Bike

Trips per day per bike (TDB) is one simple metric for comparing cities and BSS.[73] In utilizing this quantitative measure, cities may make concrete statements around the utilization of their programs while providing a basis for improvement. Some of TDB's main shortcomings are its lack of consideration for existing bicycle infrastructure, weather, and geography. However, this metric can provide a lense through which policymakers can make decisions regarding placement and expansion of stations.

The Network Effect

The 'network effect' is a commonly promoted hypothesis supporting expansion of bike-share infrastructure to increase performance. The idea behind the 'network effect' is that a linear increase in the number of stations results in an exponential increase in the possible number of trips. Though this is often used to justify rapid expansion of BSS, there is little evidence to support this purported phenomenon.[74] The 'network effect' would only be supported under circumstances where single trips require the use of multiple stations.

Case Studies

Case Study: New York City

According to this study, the implementation of bike-sharing systems in New York was found to cause a statistically significant decrease in bus ridership along routes where bikes were available.[75] Along routes shared by bikes and buses, bus ridership decreased 3.2% for every 1,000 bikes along the route. Other cities may find that bike-sharing systems can alleviate overfilled buses, decongesting common commutes. This case demonstrates that an increase in

71 City of Helsinki. Helsinki Bike-Share Program Triples After Successful Launch. Marketwired. 2017, May 19.http://www.marketwired.com/press-release/helsinki-bike-share-program-triples-after-successful-launch-2217549.htm
72 Cyrille Médard de Chardon, Geoffrey Caruso. Estimating bike-share trips using station level data. Retreived from: http://www.sciencedirect.com/science/article/pii/S0191261515000983
73 Cyrille Médard de Chardon, Geoffrey Caruso, Isabelle Thomas. Bicycle sharing system 'success' determinants. Retreived from: http://www.sciencedirect.com/science/article/pii/S0965856416307674?via%3Dihub#b0065
74 Cyrille Médard de Chardon, Geoffrey Caruso, Isabelle Thomas. Bicycle sharing system 'success' determinants. Retreived from: http://www.sciencedirect.com/science/article/pii/S0965856416307674?via%3Dihub#b0065
75 Kayleigh B. Campbell, Candace Brakewood. Sharing riders: How bikesharing impacts bus ridership in New York City. Retreived from: http://www.sciencedirect.com/science/article/pii/S0965856416304967?via%3Dihub

usage of buses or trains may not be a useful measure of the effectiveness of a BSS, especially along routes where bikes and transit behave as substitutes for one another.

Case Study: Seoul, South Korea

Gangnam-gu, a district of Seoul, South Korea suffers from high levels of traffic congestion, noise, and air pollution. In order to mitigate some of the externalities associated with existing transportation methods, the city sought to implement a BSS with the goal of reducing car trips shorter than three miles. The model used data from taxi services to estimate common routes, trip origins, and destinations. The outline of the city's BSS focused on placing bike-share stations in such a way as to make them the most convenient option of transport to selected destinations.[76] A similar approach could be used by TriMet to determine initial placement of stations.

User Satisfaction and Ease of Use

User Satisfaction

Benefits of BSS can include reduced greenhouse emissions, decreased traffic congestion, and improved health. In addition to some of these shared benefits, these systems must provide a satisfactory experience for users in order to be effective. In the following sections, we will discuss strengths and weaknesses of BSS according to users.

Ease of Use

According to a recent customer satisfaction report from Washington D.C.'s Capital Bikeshare, ease of use is one of the most important incentives for users. When asked about the primary reason for their use of bike-share, 56% of survey respondents noted that it was either the easiest or fastest way to get to their selected destination.[77]

Coordination with Transit

Bike-sharing systems can serve as both complements and substitutes to other forms of transportation. Some users replace their transit trips with bike trips, while others use bike-share systems to get to and from transit stations. To further segment the issue of integration with public transportation, bike-share use can also be affected by the presence of other ridesharing or ride-hailing transportation options.

Bike-Sharing as a Complement to Existing Transit

Capital Bikeshare discovered that approximately 71% of survey respondents used bike-share to access public transit. However, this information in itself is not indicative of a corresponding increase in use of public transit. In a recent survey of users of a multimodal mobility station in Munich, Germany, bike-sharing was one of the most utilized modes of transportation used to access the mobility station.[78] Although bike-sharing systems may not necessarily increase the use of existing transit, it provides an alternate method of reaching transit stations.

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76 Chung Park, So Young Sohn. An optimization approach for the placement of bicycle-sharing stations to reduce short car trips: An application to the city of Seoul. Retreived from: http://www.sciencedirect.com/science/article/pii/S0965856416311843?via%3Dihub

77 LDA Consulting. 2016 Capital Bikeshare Member Survey Report. Retrieved from: https://d21xlh2maitm24.cloudfront.net/wdc/Capital-Bikeshare_2016MemberSurvey_Final-Report.pdf?mtime=20170303165531

78 Montserrat Miramontes, Maximilian Pfertner, Hema Sharanya, Rayaprolu, Martin Schreiner, Gebhard Wulfhorst. Impacts of a Multimodal Mobility Service on Travel Behavior and Preferences: User Insights from Munich's First Mobility Station. Retreived from: https://trid.trb.org/View/1437143

Bike-Sharing as a Substitute of Existing Transit

As in the case of New York City, bike-sharing systems can replace some trips on public transit. This phenomena is also observed in Washington D.C., as 50-60% of survey respondents reported using the monorail or buses less often as a result of their use of bike-sharing

Recommendations

We recommend TriMet consider the aforementioned best practices and look to examples from other bike-share systems to integrate and expand the current system. Best practices to incorporate include universal payment methods via apps and cards across Portland's public transit and other close city operators. A new dockless parking with geofencing would be beneficial for TriMet in determining the best location and to help collect metrics, like trips per day, to provide grounds for informed decisions.

Relevant metrics, data collection, and analysis will drive efficient station placement and determine the overall effectiveness of Portland's bike-share program. Current best practices in regard to station placement include considering proximity of a station to a destination, identifying existing travel routes that can be replaced by bike-share trips and evaluating the success of individual stations on a consistent basis. Data collection from bikes, ride-hailing companies and third parties is imperative to assess the performance of the program

Review of Transit and Transit-Integrated Apps TriMet Collaboration Project

Team 4:
Llyswen Berna • Aaron Bush • Leah Elstrott

Executive Summary

TriMet has been a leader in embracing technology and using it to create a better experience for riders. For example, it was one of the first organizations in the country to provide open-source data to programmers so they could develop new apps. It also recently installed wireless payment on buses and trains, allowing passengers to simplify their day-to-day transit experiences. It is now investigating how apps will be used in urban mobility in the future.

Transportation apps currently range from those focused on a few specific users (i.e. PDX Bus), to those aimed at giving basic navigational information to the masses (i.e. Google Maps). Trending features identified in the app comparison include event and payment integration, multimodality options, and integration with other transportation apps. Overall, we are seeing apps move towards providing more options and real-time data, as well as integrating features to simplify the transit experience. The most important efforts over the next few years will be to establish cohesive systems and experiences that link multiple functions (tickets, maps, public transit etc.) in a single app platform. TriMet's decisions about what data to provide third-party app developers as well as what partnerships to explore (i.e. whether to partner with private companies such as Lyft or Uber, or bike-sharing companies, for example) will have a significant impact on Portland transit over the next decade.

The rising number of transit apps has led to an increase in public transportation use. This has had positive economic impacts on the transit sector as well as providing environmental benefits. Using public transportation apps has also been shown to help with public health and rural transit. There are some concerns about equal access to apps, but these can be combatted in several ways.

TriMet has been providing open-source data for just over a decade (starting with Google), but it has not been collecting data from apps as effectively. There is a significant opportunity to provide standards and build partnerships that will allow TriMet to improve its services and understanding of consumer behavior. Overall, TriMet should move to support apps that integrate payment features and provide continuous service across multiple geographic locations.

Methodology & Boundaries

The first-phase of this project was a selective review of the wide range of smartphone apps provided by transit agencies and by third-party developers. The team conducted preliminary research to develop a simple framework for assessing transit app characteristics, including features such as (but not limited to) platform, geographic range, integration with other apps, and alert functionality.

To identify which apps would be selected for analysis, the following sources were used: TriMet app list, Apple's App Store, articles about transit apps, and crowdsourcing via Facebook for friends' favorite and most-utilized apps. Portland was deemed relevant as it is the home of TriMet, and Seattle was a focus as well because it is the largest major city near Portland. Five apps from Portland were considered, four from Seattle, eight commonly cited national apps, and three noteworthy international apps, for a total of 20 apps.

Establishing boundaries was critical in the early stages of this project, as other teams performed a similar app analysis on non-transit apps. The criteria for our team's project was to include apps that:

- Are provided by a transit agency
- Are designed by a third-party developer in conjunction with a transit agency
- Have transit as a primary function

Implications for the future of the transit sector and the triple bottom line involved taking the

analysis from part one and contextualizing it within current academic research. Resources for academic literature included the University of Oregon's Library Database and Google Scholar. Lastly, a conversation with David King, Professor of Urban Planning at Arizona State University and transit expert, provided an additional perspective on future trends.

Key Features Derived from App Comparison Framework

Analysis of the transit app landscape revealed six features that stood out as desirable, trending, or important for user satisfaction. This section will define the feature, provide examples of current feature utilization within existing apps, and comment on the trajectory of the feature.

Event Integration

Definition: Capability of an app to integrate information about both events (time, location, details) with how to get to such events (public transportation, bike, ride-sharing services). Currently, Acehopper[1] is the only app we found that has integrated events with transit. This

APP NAME	App Store Ranking	Coverage	Transportation Options	Installs (Google Play)
AROUND THE US				
Acehopper	4.5	New York, Chicago, San Francisco	Bikeshare, Subway, Bus	10,000-50,000
Citymapper	4.4	39 Cities, Large Populations	All available in city	5-10 Million
Moovit	4.4	Over 1,400 cities	Bus, Train, Subway, Tram, Bike Sharing	10-50 Million
Transit	4.2	125 cities	Public Transport, Bike Share, Ride Sharing	1-5 Million
Third Rail	4	New York	Bus, Train	N/A
Google Maps	4.7	Everywhere	All available in city	1-5 Billion
Here WeGo - City Navigation	4.4	New York City, San Francisco, and major international cities	Subway, Bus, Bike, Train, Tram, Ferry	5,000-10,000
Transit Stop	4.4	Chicago Area	Bus, Subway	N/A
PORTLAND				
PDX Bus	4.2	Portland	Bus, Train	N/A
Transit Tracker	3.1	Portland	Bus, Train, Gondola	N/A
Portland Transit: Trimet bus and train times	4.8	Portland	Bus, Train	1,000-5,000
Bus@Portland	3.8	Portland	Bus, Train	1,000-5,000
Hop Fastpass	2.7	Portland	Bus, Streetcar, C-Tran	5,000-10,000
SEATTLE				
One Bus Away	3.7	handful of major cities	Bus, Train	0.5-1 Million
Puget Sound Trip Planner	1.4	Puget Sound only	Bus, Train, Light Rail, Streetcar, Ferry, Water Taxi, Monorail	50,000-100,000
Transit Tracker Seattle (King County)	3.3		Bus, Light Rail, Sounder, Ferry	N/A
Seattle Transit: Sound Transit buses	4	Seattle area	Bus, Train, Light Rail, Streetcar, Ferry, Water Taxi, Monorail	N/A
INTERNATIONAL				
Whim - Freedom of Mobility	N/A	Helsinki	Buses, Trams, Metro, Taxis, Car Rental, Bikes	1,000-5,000
WeChat	3.6	China primarily	Bike Apps, Metro, Didi (their Uber)	100-500 Million
EasyWay Public Transport	4.3	Eastern Europe	Public Transport	0.5-1 Million

APP NAME	Real Time Data	Multi-Modal	Intergration with other Apps	Offline Schedules	Stop notifications	Alerts
AROUND THE US						
Acehopper	No	No	No	Yes	No	Yes
Citymapper	Yes	Yes	Yes	Yes	Yes	Yes
Moovit	Yes	Yes	Yes	Yes	Yes	Yes
Transit	Yes	Yes	Yes	Yes	Yes	Yes
Third Rail	Yes	No	No	No	No	Yes
Google Maps	Yes	Yes	Yes	No	No	Yes
Here WeGo - City Navigation	Yes	Yes	Yes	Yes	No	Yes
Transit Stop	Yes	Yes	No	No	No	No
PORTLAND						
PDX Bus	Yes	Yes	No	No	Yes	Yes
Transit Tracker	Yes	Yes	No	No	No	No
Portland Transit: Trimet Bus and Train tTimes	Yes	Yes	No	No	No	No
Bus@Portland	Yes	Yes	No	No	No	No
Hop Fastpass	No	No	No	No	No	No
SEATTLE						
One Bus Away	Yes	No	No	No	No	No
Puget Sound Trip Planner	No	Yes	No	Yes	No	No
Transit Tracker Seattle (King County)	Yes	No	No	Yes	Yes	Yes
Seattle Transit: Sound Transit Buses	Yes	No	No	Yes	Yes	Yes
INTERNATIONAL						
Whim - Freedom of Mobility	Yes	Yes	Yes	No	No	No
WeChat	No	No	Yes	No	No	No
EasyWay Public Transport	Yes	Yes	No	Yes	No	No

unique functionality allows users to view a list of nearby events or local attractions, purchase tickets for the event, and view directions including subway, bus schedules, and bike-shares in the area. This app is listed under the 'Entertainment' category unlike the majority of the other apps reviewed. It should be noted that currently, there is no real-time public transportation data in this app, nor the ability to pay for transit through the app. Nevertheless, this app surpasses its competitors like Nearify and Eventful, which are apps that have the event-locating capability but do not provide any transit information on how to get to the event. Google Maps has similar functionality, but rather than identifying events, it is focused on providing directions and information related to permanent attractions like restaurants and cafes.[2] Likewise, Citymapper has partnered with Yelp!

Generally the future for transit-event integration app functionality seems promising. The potential for partnerships as well as increased traffic to the transit app due to popular events would be mutually beneficial. This functionality could serve both locals and tourists. The big question would be whether events are simply outside the scope of a transit app. In that case, could a partnership model between an event app and transit app *without* integration (i.e. The event app has a 'How to get here' link that redirects to the respective transit app) actually make the most sense?

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1 ITunes-Navigation. (n.d.). Retrieved December 02, 2017, from https://itunes.apple.com/us/genre/ios-navigation/id6010?mt=8

2 Maps & Navigation - Android Apps on Google Play. (n.d.). Retrieved December 02, 2017, from https://play.google.com/store/apps/category/MAPS_AND_NAVIGATION?hl=en

If integration were to happen, it would be important to figure out how both recurring events and one-time events can interact with the app in a way that is sustainable long-term. There would certainly be marketing potential through cross-promotion for both the event and the transit app. It would be ideal to incorporate real-time data for both ticket availability and pricing for events and transit, and allow users to pay for either/both via the app.

Payment Integration

Definition: Ability of the app to provide comprehensive transit information (including routes, schedules, maps) and the ability to pay for selected transit option within the app.

The current domestic apps are lagging in terms of payment integration. Moovit is the only transit app within the scope of our analysis in the US that has integrated payment features, and it is for the bike-share program exclusively. Internationally, there has been more forward momentum. Whim is available in the Helsinki region and has fully integrated payment for taxis, public transportation, ferries, rental cars, and bike-shares[3]. Users are able to choose from a monthly package to cover *all* transportation (including public transport, taxis, city bikes, and rental cars), or select pay-as-you-go (but still pay through the app).

In China, WeChat has effectively connected the entire population, including their payment profiles, to this app. In terms of transportation, they have linked to outside vendors to provide further options and continuity for customers. The most important payment aspect of this app is that it is linked directly to a bank account, so users can complete a variety of transactions without re-entering their information. WeChat has also developed a simple QR scanning technique that significantly lowers the infrastructure investment to provide payment options. Rather than installing complicated infrastructure at each payment location, WeChat was recently able to partner with public transit in a handful of Chinese cities so that riders could simply scan a QR code and pay for their ride.

In the U.S., it is important to recognize existing payment options. For TriMet, riders can use Hop Fastpass to pay for their rides. This app does not integrate with transit schedules or maps, and has no trip planning capabilities. However, it does have the advanced feature of 'fare-capping' in which two ticket purchases in the same day will earn the rider a day pass. Additional rides that day will be free, and this feature did not require any guessing or foresight on the rider's behalf. It works the same for a monthly pass, which could present large savings for some. In King County, the payment mechanism is nearly identical. Transit GO can be used to purchase tickets, but not trip-plan. The key takeaway is that in the predominant Pacific Northwest transit systems, passengers need two separate apps to plan and purchase a ride on public transit. The opportunity for integration is conspicuous.

Integration with Other Transportation Apps

Definition: A transit app extends beyond its core mode of transport by integrating with other apps.

A good example of the payment integration feature is Google Maps and the integration with Uber, in which a user can book an Uber ride without leaving the Google Maps app. This feature is also available in Moovit, Transit, and Citymapper, which are three of the most popular and highly ranked transit apps nationwide.[4] It is worth noting that Citymapper integrates with Lyft,

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3 Is Whim the Netflix of mobility? (n.d.). Retrieved November 29, 2017, from https://www.helsinkismart.fi/portfolio-items/whim/

4 10 best transit apps for Android. (2017, July 02). Retrieved November 28, 2017, from https://www.androidauthority.com/best-transit-apps-android-782796/

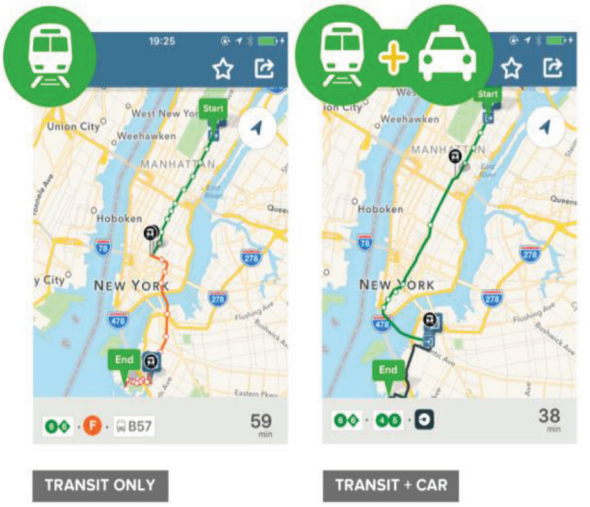
Dyani Sabin on March 1, 2017. (n.d.). The 3 Best Transportation Apps That Aren't Google Maps. Retrieved November 28, 2017, from https://www.inverse.com/article/28402-public-transportation-google-maps-alternatives

Kazmucha, A. (2014, April 03). Best transit apps for iPhone: Google Maps, Moovit, Citymapper, and more! Retrieved November 28, 2017, from https://www.imore.com/best-us-transit-apps-iphone-google-maps-moovit-citymapper-more

DiPane, J. (2016, November 03). Best Transit App. Retrieved November 28, 2017, from https://www.androidcentral.com/

Uber, and Carshare while Transit integrates with Uber, Car2Go, and BikeShare. The new version of Maps by Apple has added a 'Ride' option, which integrates with Uber and Lyft, and has a public transit option as well.

The relationship between transit and other transportation apps could be mutually beneficial in some ways, for example cross-promotion and the ability for the services to complement each other in a multi-part trip. On the other hand, the competition is apparent, especially for short, inner-city trips and it could be especially intimidating for a transit company to suggest a third-party service on their own app. The key to a healthy partnership would be identifying the complementary services and maximizing those, while openly acknowledging the potential competition and problem-solving ahead of time. Likely, the reason this type of integration is uncommon can be attributed to these challenges.



Example 1- Citymapper's Multi-Modal functionality

Multimodality

Definition: The capacity of an app to offer trips that incorporate multiple modes of transportation (e.g. walk, bike, train, drive, bus, taxi, etc.) as preferred by the rider.

Within the current app-scape, it is very common to see a 'Walk and Transit' option in which the user will follow a walking route to the transit stop/station, then ride transit, and post-ride she will walk to her specific destination. While this is multimodal, it is so by necessity; one cannot take transit without a walking component.

Within the scope of this research, Citymapper is the most promising example offering trips that combine cars (private or TaaS models like Uber) with transit.[5] See Example 1 for Citymapper's display of how public and private can and can coexist.

A few years ago, moovel partnered with TriMet to make the TriMet Tickets App,[6] which offered a unique 'Bike and Transit' option and allowed the user to specify a maximum biking mileage. Google Maps has a purely 'Bike' option, but this does not integrate well with any other form of transportation.

Overall, there are limited examples and it appears multimodality has not been fully explored in the app space.[7] The ability for a rider to select his or her preferred forms of transportation in order of priority, plug those preferences into an app, and receive suggestions for creative multimodal routes, has significant potential. For instance, these options might be: bike eight miles to transit station, which would take the rider the remaining 12 miles; Lyft five miles from

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best-transit-app

5 Butcher, M. (2016, March 31). Citymapper launches seamless routing between Cabs and Public Transit. Retrieved November 29, 2017, from https://techcrunch.com/2016/03/31/citymapper-launches-seamless-routing-between-cabs-and-public-transit/

[9] C. (2016, March 31). Trips that combine Public Transit & Cars – Citymapper – Medium. Retrieved November 29, 2017, from https://medium.com/citymapper/combining-transit-with-cars-in-cities-5ecc2cad8fac

6 Longteig, A.(2016, May 5). TriMet Tickets app now helps riders connect to other transportation options. Retrieved November 23, 2017, from http://news.TriMet.org/2016/05/TriMet-tickets-app-now-helps-riders-connect-to-other-transportation-options/

7 Kramers, A. (2014). Designing next generation multimodal traveler information systems to support sustainability-oriented decisions. Environmental Modelling & Software, 56, 83-93. doi:10.1016/j.envsoft.2014.01.017

home to the train, then take the train into the congested city area. The app could also consider time limitations, financial restrictions, limited mobility (wheelchair, no stairs, etc.) and other rider preferences to provide a customized trip.

Geographic Scope and Availability

Definition: Where a transit app is available and what geographic range it covers. There are three large buckets: city specific apps, multi-city apps, and universal apps.

City Specific Apps

The two cities explored in the context of this research, Seattle and Portland, provide a host of examples of these types of apps. In Portland, PDX Bus, Transit Tracker, and Bus@Portland are a few examples. These offer several advantages such as features customized to the city itself, downloadable timetables, and maps that can be accessed offline, a look and feel that resonates with the community, and the ability to be the most comprehensive app due to the narrow scope. Despite these advantages, the matrices (Appendix A) show that on average, these city-specific apps are ranked lower according to app store rankings than are multi-city and universal apps. This may be attributed to the smaller scale, and therefore fewer resources, that are invested into the app development and maintenance.

Another trend observed in this category is the movement toward regional apps as opposed to city specific apps. Puget Sound Trip Planner in Seattle and the surrounding area is a good example of an app that is designed to serve an entire region–and is not constrained to one city. This app includes bus, train, light rail, streetcar, ferry, water taxi, and monorail information. Above all, it provides a solution to commuters living in suburbs or outside of the city and travel in for work, leisure, family, medical appointments, or a variety of other reasons.

Multi-City Apps

Moovit is available in over 1,400 cities, Transit in 125 cities, and Citymapper is in 39 of the largest cities worldwide. These apps either automatically use location services to identify which city the user is in, or they ask the user directly. This allows the app to download and access only the small portion of data needed for that city, also providing a better app experience for the user in Los Angeles who most likely does not want timetables from Hong Kong stored on their phone. These apps are great for a city experience, or perhaps an urban tourist. However, users may be frustrated to find their favorite app is not available everywhere. Residents of small and medium sized cities may disapprove of apps that they know are realistically never going to come to their city. Finally, while their functionality and interface might be superior to local apps, their ability to provide comprehensive local data is not guaranteed.

Universal Apps

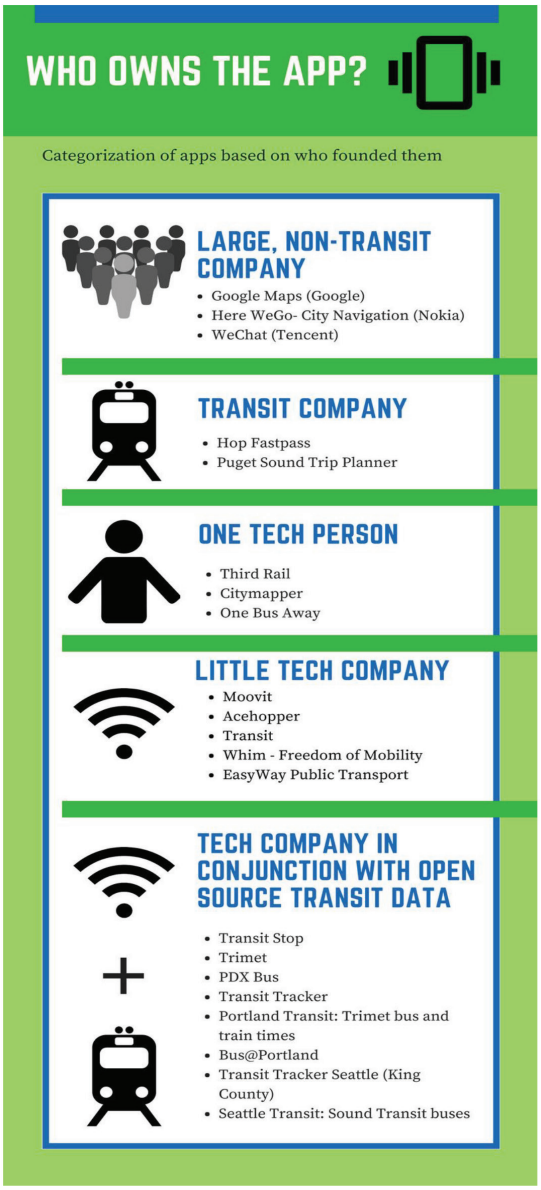
Google Maps and Apple Maps are the closest to being universal at this point. There are rural and underdeveloped areas still missing, and these apps rely on internet or a data network connection for full-functionality, which also is not available everywhere. These apps save the user from requiring multiple apps for traveling and commuting. The downside is the accuracy of information for each city; common complaints include outdated schedules and missing, city-specific transit options.

Real-Time Data & Notifications

Definition: App technology that uses sensors or crowd-sourced data to provide users actual arrival times rather than static schedules. Notifications pass along these real-time updates to users.

Perhaps the most prominent and widespread trend is the inclusion of real-time data in an app. No longer will a regular schedule do the job. Riders want to know cancellations, delays, and ideally the exact location of the transit at any moment. One Bus Away was the first app in Seattle to use the real-time tracking equipment on Metro buses to provide riders a live map showing the location of the bus at all times.[8] Transit is an example of an app that relies on crowdsourcing rider-data to provide accurate, real-time data to other users.[9] This crowdsourcing approach can work in the absence of physical transit tracking equipment. It can often be more precise than physical tracking in circumstances where updates may only happen at intervals, or rely on transit activating a sensor. The downside of crowdsourcing is that it is density dependent; for instance, the location of an unpopular bus at midnight in the suburbs may not be available due to scarcity of other riders.

Riders are also increasingly demanding real-time notifications about the arrival of their bus, or while on the bus, that their stop is next. For example, PDX Bus in Portland changes the color of the icon to red if the bus is leaving in under five minutes, and provides both alerts and stop notifications. At this time, it seems that about half of transit apps studied have this functionality.



Highlights of Additional Unique and Innovative App Features

While the previous section highlighted major trends being seen across a variety of apps, the following features were unique to a single app. The selected features stood out as being creative and having potential for greater application. TriMet has a demonstrated interest in being a leader in innovation in the transit space. For this reason, it is important to not only look at the major trends in apps, but the highly-innovative ideas as well.

Rain Safe Option: Citymapper has the option to select a 'Rain Safe' route that is designed to limit exposure to the elements. This feature seems particularly well-suited to the Pacific Northwest region.

Calories, Trees and $: Another exciting feature of Citymapper is the tally of calories burned, trees saved, and money saved. The feature allows the user to compare routes based on these stats. It also serves as a virtual 'high-five' for using public transit as riders have burnt more calories, and saved both trees and money. Finally, it allows riders to look at your personal patterns of transportation, and compare them with the rest of the city.

8 *Ferris, B., Watkins, K., & Borning, A. (2010). OneBusAway. Proceedings of the 28th international conference on Human factors in computing systems - CHI 10. doi:10.1145/1753326.1753597*

9 *Etherington, D. (2016, December 20). Transit app begins crowdsourcing data to provide accurate, real-time info. Retrieved November 29, 2017, from https://techcrunch.com/2016/12/20/transit-app-begins-crowdsourcing-data-to-provide-accurate-real-time-info/*

Disability Options: EasyWay Public Transport is an Eastern European app that allows riders to select 'Wheelchair Accessible Transport'. It is surprising this feature is not more common.

Gamification: Few of the transportation apps in the matrices currently use gamification. Moovit awards points for users who report delays, incidents, or information for other riders. This gamification technique resembles the navigation (not transit-specific) app, Waze, in which users are rewarded for reporting roadway conditions by receiving points and leveling-up their 'mood', plus rankings are on a public leaderboard. Citymapper's tally of Calories, Trees Saved and Money Saved is also a form of gamification, especially because it can be accumulated over time and compared with other users. One final example is Singapore's government, which applied creative gamification to their Travel Smart Rewards program. Users who took unpopular transit times and responded to transit-related questionnaires received points that could be applied towards future transit rides.

App Categorization: Who Owns Apps

The foundation of these apps is another dimension to consider. The vast majority of the apps were founded by small tech developers in conjunction with open source transit data, similar to TriMet's app portfolio. Others were founded by independent tech companies who use the transit data but do not brand or associate directly with the transit agency. Some apps were not founded by a company at all, but an individual developer with a vision. For instance, Third Rail was developed by an engineer who never wanted to wait for a bus again and now works for Facebook.[10]

Small tech companies are responsible for the creation of most of the apps in this analysis, however there are a few very large companies who have contributed apps, specifically Google with Google Maps, Tencent with WeChat, and Nokia with Here WeGo.

Interestingly, only two apps were founded by transit agencies themselves: Hop Fastpass (TriMet) and Puget Sound Trip Planner (King County Metro Transit). Both of these transit agencies host a wide array of apps developed by third-party developers with their open-sourced data, however they have each chosen to take ownership over just one single app.

It is difficult to make accurate and inclusive generalizations about the implications of app ownership. It can be inferred that who owns the app may impact their likelihood to promote one form of transit or another, or partner or integrate with others. Additionally, the forward trajectory of the app depends significantly on the end-goal of the app founder, whether it be brand recognition, providing the best transit service, or maximizing profit, for example. Individual apps are becoming increasingly integrated into larger platforms (i.e. Uber into Google Maps), which may simultaneously reduce usage of Uber's app and increase utilization of Uber's service. It ultimately depends on the mission of the app developer or company as to whether the loss of their app is problematic, or relatively inconsequential.

Lastly, the future potential of the app also depends on the availability of resources (i.e. sufficient staff to provide customer service, developers to resolve glitches and continuously modernize the app, etc.), and the availability of resources is highly correlated with the size and partnerships available to the company. This inevitable reality may make it more challenging for the small, independent apps to stay relevant long-term, a trend that will be discussed further in following sections.

10 Shady Gabal. (n.d.) LinkedIn Profile page. Retrieved November 30, 2017 from https://www.linkedin.com/in/shadygabal

Future: Implications for Transit Sector

Simplicity and Integration

The goal of any transit service is to move people from point-to-point. Schedules, timetables, and other information are useful at helping people make decisions about their travel, especially when they do not have specific deadlines or events in mind. However, for everyday users, relying on timetables is often unnecessary and confusing. Google Maps and Uber are perfect examples of apps that take complex transit problems and make them relatively straightforward. We believe that apps like these will become more common and proficient at integrating features. While TriMet may not have the ability to control exactly how developers and private companies present or design their products, it can work with them to set standards and provide integration opportunities.

The Whim app being debuted in Helsinki provides an example of the cross-functional relationships and agreements that are necessary to provide a seamless integration platform.[11] TriMet can partially dictate how these apps and businesses will function through its willingness to provide seamless payment features or give others the right to sell monthly transit passes. Choosing exactly how payment will be enabled is one area that TriMet has power and also an opportunity to help make the transit experience simpler and more efficient.

In contrast to Whim, which provides access to several different types of transit through one payment, WeChat simply provides easy connections to separate app services (bike-share, ride-hailing etc.) and integrates the payment feature. Building this type of partnership will allow users to move across municipalities without having to re-enter payment information or search for additional route options. Ideally, users will be able to purchase tickets and see total fares and route instructions for trips ranging in length from 1 to 1,000 miles.

Tradeoffs - Simplicity and Information

App developers make a number of decisions about not just what the app will do, but how it will convey information to the users. As we see apps moving towards being more comprehensive, capable, and integrated, developers must choose between providing as much information as possible, and keeping the app functionality simple and streamlined.[12] Although there are no distinct separations, we see three general categories: apps that minimize information to keep the product simple to navigate, apps that provide a handful of extra features or information, and apps that focus on providing many details and options. In the coming years, it is likely that developers will continue to experiment and discover what information is most useful to travelers. Below are a few examples:

Google Maps

Google Maps is one of the most ubiquitous and capable mapping tools. It provides multi-modal directions, street views, and options to see traffic or even satellite images. Still, as a transit tool it tends to be a little simpler than others. It was originally designed with car transit in mind, and has slowly integrated more capable public transit options. Google has made the decision not to include some transit modes, city transit maps, or timetables in an effort to keep the point-to-point navigation easy and intuitive.

11 Whim App. (n.d.). Retrieved from http://whimapp.com/fi-en/
12 The Future of Transit: 3 Software Trends You Need to Know. (2017, May 02). Retrieved November 29, 2017, from http://transloc.com/future-transit-3-software-trends-need-know/

Citymapper

In comparison to Google Maps, Citymapper provides more information, but requires a bit more mental investment on the part of the user. It shows maps of different transit agencies, provides timetables, as well as other integrations from Lyft and Uber. However, it doesn't ever give a screen view that is only a map (Google maps does), and sorting through the information takes a bit more time. Both Google Maps and Citymapper are designed primarily for point-to-point navigation with mode selection.

Transit PDX

Transit PDX does point-to-point navigation, but it also includes significantly more information about Portland-specific travel than other 'all purpose' transit apps. Apps like Transit PDX tend to be city-specific and focus on riders who know what types of public services are available. Riders can then use the large amount of information to decide how they want to travel. One consumer complaint of apps that include this level of detail is that they tend to take up both more memory on the phone and use more data than simpler apps.

Recommendations for TriMet

TriMet has thus far operated on the assumption that providing open access to data and creating a level playing field for app developers leads to innovation and diverse options. This policy has had the intended result of spurring innovation (50 apps on the TriMet website), but it is possible that both TriMet and its customers would be better served by fewer, better options. Policies promoting standardization of data, centralization of users, and decisions regarding potential partnerships are some of the more important strategic maneuvers TriMet will likely need to navigate in the next 3-5 years.

Standardize Data

TransLoc, a transit technology company, presented the opinion that agencies like TriMet have promoted policies that result in offerings that are 'a mile wide and an inch deep.'[13] What they mean is this: a wide selection of narrowly focused apps spreads users, and the information about their habits, across an array of platforms that may not share data collection techniques or strategies. The data created by transit apps is potentially as useful to TriMet as TriMet's data is to app developers.

The more that TriMet can nurture relationships where it provides basic transit data and in return collects information about how people are using services, the more it will be able to improve those services in the future. As things currently stand, TriMet would have to sift through information provided by dozens of apps in non-standard formats to discern rider habits. By setting standards for data and requiring it to be shared, TriMet may discover common point-to-point routes or multi-modal transportation decisions that prove illuminating as it seeks to adjust improve or adjust its own services. An example of this is Citymapper's use of their own data to identify underserved transit routes in London. To solve this problem, Citymapper has decided to start a night bus route outside of the normal transit system.[14]

Create Guidelines for Integration

Payment integration is a clear example of how TriMet can create standards that allow for win-win solutions. TriMet's Hop Fastpass is a great start for more modern fare collection. However,

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13 Cohen, J. (2017, May 02). The Future of Transit: 3 Software Trends You Need to Know. Retrieved December 02, 2017, from http://transloc.com/future-transit-3-software-trends-need-know/

14 Vincent, J. (2017, July 20). Transport app Citymapper is launching a real, paid bus service in London. Retrieved December 02, 2017, from https://www.theverge.com/2017/7/20/16002800/citymapper-bus-route-location-service

as mentioned in the 'Key Features' section, it is not integrated with other systems or apps. It is possible that TriMet may wish to keep its system capped in this way for security or control reasons. However, we believe that integrating payment directly within other apps will be highly desirable in the future. Customers will be able to move from city to city, or between modes of transportation, without having to use multiple apps or payment features. Using accepted standards, or working with others to create them, TriMet can design a system in which apps become more modular, so that desirable features or functions can be carried through from region to region or between different purposes in the same city.

Organize and Prioritize App Page

There are currently almost 50 apps listed on TriMet's website that range from small, Portland specific apps, to market leaders from Google and Apple.[15] While a brief description of each is listed, there is no easy way for users to tell which apps are popular or function most effectively. The app stores themselves provide some information (basic reviews and function lists), but sorting through it is confusing and time-consuming. TriMet should find a way to leverage professional reviews, competitions, or other metrics that will allow it to highlight different apps for being best at what they do. As customers migrate to specific apps, TriMet will be able to monitor their usage more easily and potentially provide better service. It is important to acknowledge that this suggestion may seem counter to TriMet's open-data philosophy, and may alienate participating app developers. However, if managed carefully, this suggestion would simply provide a way for users to filter and prioritize apps, and would not necessitate TriMet 'picking favorites'.

Provide Developers with Best Practices/Functions

In addition to showcasing top apps, TriMet has an opportunity to help developers incorporate the most popular features in future projects or updates. Here is a brief list of useful features, including some that were briefed in the discussion section above:

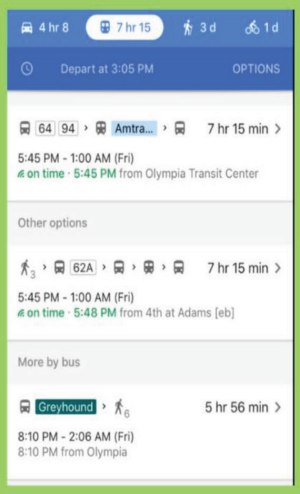
- Alarm/Reminder to get off train or bus at the correct stop
- Alarm/Reminder to leave current location to reach destination by the desired time
- Color-coding to show when trains, buses, or other transit is expected to arrive
- Incorporation of multi-modal options and user preferences
- Payment features integrated into apps
- Local events, food, or sights
- Fare estimates
- Ability to search by 'cheapest,' 'fastest,' 'shortest'
- 'Favorites' tab that shows most used routes/timetables

Triple Bottom Line Implications: Environmental, Economic, Social

Environmental

The increase in app efficiency has led to increased ridership of public transportation.[16] More people using public transit is inherently better for the environment, assuming that some of these riders would have taken personal vehicles or taxis instead. Citymapper capitalizes on this difference by showing how much CO^2 you are saving by taking alternate forms of transit from a car.

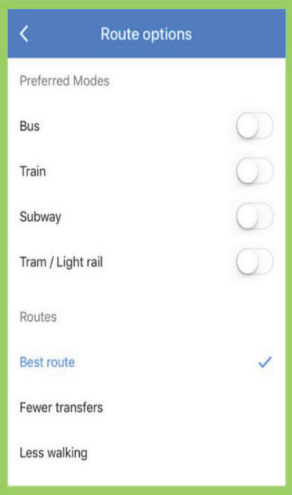
15 TriMet App Center . (n.d.). Retrieved December 02, 2017, from https://TriMet.org/apps/
16 Greenblatt, J. B., & Shaheen, S. (2015). Automated Vehicles, On-Demand Mobility, and Environmental Impacts. Current Sustainable/Renewable Energy Reports, 2(3), 74-81. doi:10.1007/s40518-015-0038-5

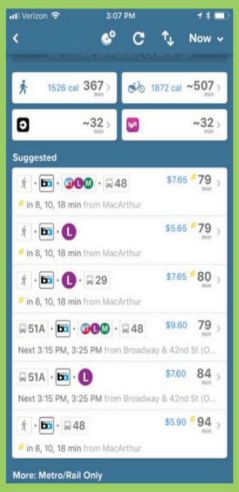


GOOGLE MAPS

At left:
Google maps offers alerts and modality choices, although it only shows a few options for any given route.

At right:
The 'preferred modes' options only appear once you have selected the 'transit' category. This type of integration may prove useful in the future - detailed options will only appear if they are relevant to the modes you have selected.

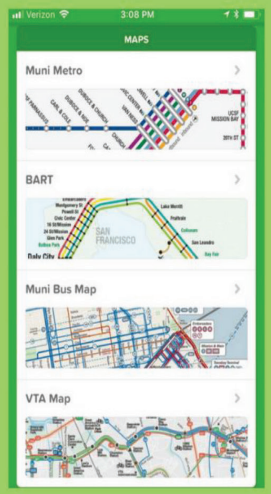


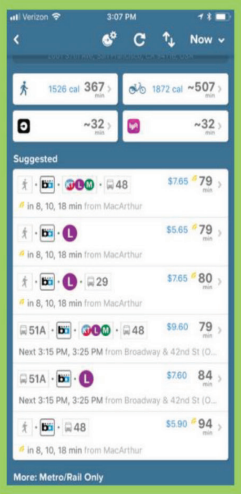


CITYMAPPER

At left:
Citymapper shows a number of different route options (the list extends beyond this image) as well as times and cost.

At right:
Scrolling down the main screen on Citymapper provides links to the transit maps (in addition to routes and timetables).

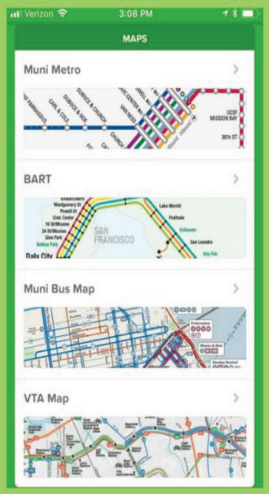




TRANSIT PDX

At Left:
Transit PDX provides links to timetables for a number of different modes particular to Portland (including the Aerial Tram).

At Right:
Transit PDX also has links to many of Trimet's resources, showing the extra level of information that many local services provide.



Economic

Apps that have real-time data have led to saving time for both riders and the transit teams[17]. Having this data available has significantly decreased the number of 311 calls placed to find out when a bus will be at a station. More people are riding public transportation because apps and mobile technology have decreased the three largest barriers (lack of security, timely information, and convenience).[18] In addition, the time spent waiting for public transportation has become less of an issue as many people use their phones during this period so they feel productive.

When looking at ticketing, apps help consumers and transit authorities save money. Some apps, such as Hop Fastpass, help consumers avoid overpaying for their rides. Using the app makes paying efficient as well as adjusting payment based on numbers of uses. In addition, implementing an app payment system was found to be less expensive (by $50 million) than installing new smartcard payment systems.

Social

Having public transit be more accessible has been shown to help people meet their daily physical activity recommendations through walking to the stops.[19] This was found to be especially true for low-income and minority groups.

Focusing specifically on rural areas, apps could be used to help create deviated routes for paratransit pick-up to avoid needing a separate bus. Using the app to confirm that the person is ready and waiting helps to reduce the cost of no-shows. The real-time data is also more important in rural communities as their bus routes tend to have less frequent pick-up times and ridesharing often does not serve these areas.[20]

One concern for apps is that smartphones are not accessible to the entire population. 77% of American adults own a smartphone, which means that if transit moves towards using apps alone they would be missing 23% of the population.[21] These would most likely be the lower-income or unbanked individuals who rely on public transport more as they cannot afford personal vehicles or ride-sharing options. If a transit agency does decide to move to app payment systems or information provided by apps, they need to have additional systems in place for individuals who do not own smartphones. Having paper schedules available and tickets/rides able to be purchased using cash is essential to ensuring everyone will still be able to ride public transit.

Conclusion

Our review of transit apps and transit-integrated apps highlighted several prominent features that have emerged in the app landscape including event and payment integration, multimodality, real-time data and notifications, and integration with other transportation apps. The movement towards integration in the app space is inevitable. Consequently, the recommendations for TriMet focus on centralization, integration, and increased oversight and guidance for app developers. The world of apps moves quickly, and armed with these best

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17 Nath, J. (2011). Reimagining government in the digital age. National Civic Review, 100(3), 19-23. doi:10.1002/ncr.20070

18 Dutzik, T., Madsen, T., & Baxandall, P. (2012, November 30). A New Way to Go: The Transportation Apps and Vehicle-Sharing Tools that Are Giving More Americans the Freedom to Drive Less. Retrieved November 29, 2017, from https://trid.trb.org/view.aspx?id=1264807

19 Besser, L., & Dannenberg, A. (2005). Walking to Public TransitSteps to Help Meet Physical Activity Recommendations. American Journal of Preventive Medicine, 29(4), 273-280. doi:10.1016/j.amepre.2005.06.010

20 Desouza, K. C., & Bhagwatwar, A. (2012). Citizen Apps to Solve Complex Urban Problems. Journal of Urban Technology, 19(3), 107-136. doi:10.1080/10630732.2012.673056

21 Smith, A. (2017, January 12). Record shares of Americans now own smartphones, have home broadband. Retrieved December 02, 2017, from http://www.pewresearch.org/fact-tank/2017/01/12/evolution-of-technology/

practices, we are confident TriMet can maintain their position as one of the leading transit agencies in modernization and innovation.

Appendix A- Matrices

Table 1: Basic App Comparison

APP NAME	App Store Ranking	Coverage	Transportation Options	Installs (Google Play)
AROUND THE US				
Acehopper	4.5	New York, Chicago, San Francisco	Bikeshare, Subway, Bus	10,000-50,000
Citymapper	4.4	39 Cities, Large Populations	All available in city	5-10 Million
Moovit	4.4	Over 1,400 cities	Bus, Train, Subway, Tram, Bike Sharing	10-50 Million
Transit	4.2	125 cities	Public Transport, Bike Share, Ride Sharing	1-5 Million
Third Rail	4	New York	Bus, Train	N/A
Google Maps	4.7	Everywhere	All available in city	1-5 Billion
Here WeGo - City Navigation	4.4	New York City, San Francisco, and major international cities	Subway, Bus, Bike, Train, Tram, Ferry	5,000-10,000
Transit Stop	4.4	Chicago Area	Bus, Subway	N/A
PORTLAND				
PDX Bus	4.2	Portland	Bus, Train	N/A
Transit Tracker	3.1	Portland	Bus, Train, Gondola	N/A
Portland Transit: Trimet bus and train times	4.8	Portland	Bus, Train	1,000-5,000
Bus@Portland	3.8	Portland	Bus, Train	1,000-5,000
Hop Fastpass	2.7	Portland	Bus, Streetcar, C-Tran	5,000-10,000
SEATTLE				
One Bus Away	3.7	handful of major cities	Bus, Train	0.5-1 Million
Puget Sound Trip Planner	1.4	Puget Sound only	Bus, Train, Light Rail, Streetcar, Ferry, Water Taxi, Monorail	50,000-100,000
Transit Tracker Seattle (King County)	3.3		Bus, Light Rail, Sounder, Ferry	N/A
Seattle Transit: Sound Transit buses	4	Seattle area	Bus, Train, Light Rail, Streetcar, Ferry, Water Taxi, Monorail	N/A
INTERNATIONAL				
Whim - Freedom of Mobility	N/A	Helsinki	Buses, Trams, Metro, Taxis, Car Rental, Bikes	1,000-5,000
WeChat	3.6	China primarily	Bike Apps, Metro, Didi (their Uber)	100-500 Million
EasyWay Public Transport	4.3	Eastern Europe	Public Transport	0.5-1 Million

Table 2: In-Depth App Functionality Comparison

APP NAME	Real Time Data	Multi-Modal	Intergration with other Apps	Offline Schedules	Stop notifications	Alerts	Favorite Locations	Ticket Purchase
AROUND THE US								
Acehopper	No	No	No	Yes	No	Yes	No	Yes
Citymapper	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Moovit	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Transit	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Third Rail	Yes	No	No	No	No	Yes	No	No
Google Maps	Yes	Yes	Yes	No	No	Yes	Yes	No
Here WeGo - City Navigation	Yes	Yes	Yes	Yes	No	Yes	Yes	No
Transit Stop	Yes	Yes	No	No	No	No	Yes	No
PORTLAND								
PDX Bus	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Transit Tracker	Yes	Yes	No	No	No	No	No	No
Portland Transit: Trimet Bus and Train tTimes	Yes	Yes	No	No	No	No	Yes	No
Bus@Portland	Yes	Yes	No	No	No	No	Yes	No
Hop Fastpass	No	No	No	No	No	No	Yes	Yes
SEATTLE								
One Bus Away	Yes	No	No	No	No	No	Yes	No
Puget Sound Trip Planner	No	Yes	No	Yes	No	No	No	No
Transit Tracker Seattle (King County)	Yes	No	No	Yes	Yes	Yes	Yes	No
Seattle Transit: Sound Transit Buses	Yes	No	No	Yes	Yes	Yes	Yes	No
INTERNATIONAL								
Whim - Freedom of Mobility	Yes	Yes	Yes	No	No	No	Yes	Yes
WeChat	No	No	Yes	No	No	No	No	Yes
EasyWay Public Transport	Yes	Yes	No	Yes	No	No	Yes	No

NOTE: If it was unclear is app provided functionality or not, a value of “No” was given.

Exhibit 1: Key to Table 2

Real-Time Data-App technology that uses sensors or crowd-sourced data to provide users actual arrival times rather than static schedules.

Multi-Modal-The capacity of an app to offer trips that incorporate multiple modes of transportation (i.e. walk, bike, train, drive, bus, taxi, etc.).

Integration with other Apps- A transit app extends beyond its core mode of transport by integrating with other apps.

Offline Schedules-Provides schedules to transit routes when not connected to wiki or cellular data.

Stop Notifications-Sends a push notification when your stop is coming up.

Alerts- Sends push notifications when there are updates to the transit schedule.

Favorite Locations-A user can save locations in the app to make it easier to navigate to common locations.

Ticket Purchase-Ability to pay for selected transit option within the app.

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Professor of Urban Planning at Arizona State University.

King, D. (2016, October 05). What Do We Know About the Last Mile. Retrieved November 29, 2017, from https://transportist.org/2016/10/06/what-do-we-know-about-the-first-milelast-mile-problem-for-transit/

Review of Other Urban Mobility Apps

Team 5:
Eric Buckland • Matt Currier • Adam Hamilton

Abstract

We assess other urban mobility apps and their potential uses as an integrated framework for TriMet. Our research is focused on three integrative platforms: Migo, Waze, and SMART Urban Mobility. Our findings show that there are opportunities available for TriMet to provide data to third-parties that will produce a positive impact on urban mobility. While a public-to-business integration is currently viable, there are barriers to providing app integration from a business-to-business prospective. As app integration is still currently an emerging field, we expect market forces to help push cooperation between app developers in the near future.

Introduction

Background

Transportation apps are shifting towards more integrative applications to provide the user with a streamlined and convenient experience. As these apps are established, TriMet has important decisions to make regarding what type of partnership would be the best fit for their circumstances. Provided in the following pages is our team's assessment of individual third-party apps through the use of an integrated framework that will aide TriMet in their decisions.

Scope and Focus

The scope of our team's research considers urban mobility apps separate from those targeted at transit users. This app segment is generally dominated by apps for vehicle drivers, ride-hailers, and bike-sharers.Our research concentrates on three integrative app platforms and the individual third-party apps that comprise these integrative apps. The three integrative app platforms of focus are Migos, Waze, and SMART Urban Mobility. Furthermore, our team distinguished the individual third-party apps into two broad categories: ride-hailing apps and bike-sharing apps. Our team produced these two categories based on the type of apps that are included in the integrative app platforms listed above. Listed below are the individual third-party apps assessed within this report.

Ride-Hailing Apps:

- Lyft
- Zoro
- ReachNow

Bike-Sharing Apps:

- Biketown
- Sobi
- Ofo
- Limebike

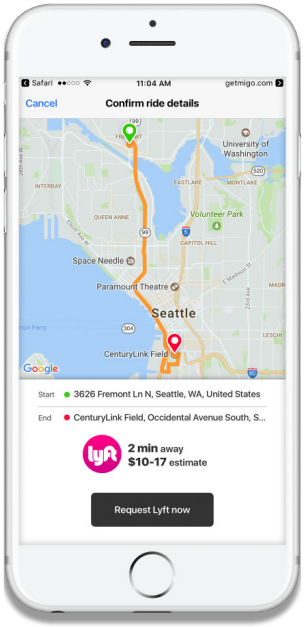
Methodology

The preliminary phase of our research was to determine what integrative app platforms were available on the market. From there we selected three of the most significant apps from our analysis, developing a framework to assess the their functionality, integration with individual third-party apps, notification alerts, marketing messages, and multimodality. To provide TriMet with context, we included in our assessment what individual third-party apps were using integrative app platforms, along with some of their individual unique app functionalities. Our resources include: app websites, website article and journals, customer testimonials, and first-hand use of each app.

Integration Apps

Migo

Background



Migo is a Seattle-based free transportation search engine that helps consumers find the best way from point A to point B[1]–whether that means closest, cheapest, most environmentally friendly, or simply the coolest option to get from place to place.[2] Starting in the Pacific Northwest, Migo is the first app available in the U.S. that allows consumers to search and compare multiple types of personal transportation.[3] Migo is currently only offered on iOS, however, they are working on an android platform. App companies featured in Migo includes: Lyft, Zoro, ReachNow, Ofo, Biketown, Sobi, and Limebike.

Event Integration

As an on-demand ride service, Migo allows users to compare the locations and prices of nearby taxi, car-sharing, bike-sharing, and ride-hailing companies all in one app. For example, a user looks at their phone to hail a Lyft, but it seems pricer than they thought so they open their Zoro app. However, they decide ReachNow would work better, so they open a third app. The user sees ReachNow would take too long, so now they have to go back through their other urban mobility apps.[4] With a simple set-up of an account, Migo allows a user access to information from 10 apps on only one.[5]

Payment Integration

Much like the individual apps Migo partners with, most rides can be paid for in app. However, some partnerships might require cash or credit in the car or bike station.[6] One unique feature about the payment mechanism with Migo is if the user has the ability to pay in app, the user does not need to open the individual third-party company's app to pay for their transportation. For example, if a user hails a Lyft on Migo, the user can pay in the Migo app and is not required to open their Lyft app to pay on their app platform.

Data Collection

Like many applications, Migo utilizes the user's GPS location to determine the options available–whether it is ride-hailing, bike-sharing, or car-sharing. In addition, Migo uses the data from partnerships to provide real-time updates about the locations and prices of their cars, cabs, and bikes. This could potentially create an avenue for TriMet to pursue, as Migo could use TriMet's public data to provide users with real-time information about the locations, prices, and times of their transit operations.

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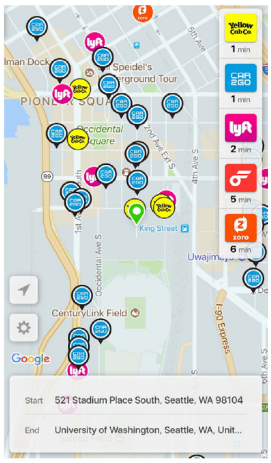
1 https://www.getmigo.com/
2 https://transportationtodaynews.com/news/5304-launch-migo-search-engine-provides-demand-rides-seattle-portland/
3 https://www.prnewswire.com/news-releases/smart-cities-seattle-and-portland-get-even-smarter-with-the-launch-of-migo--a-new-search-engine-for-on-demand-rides-300512046.html
4 https://www.seattletimes.com/seattle-news/transportation/new-app-connects-you-to-multiple-on-demand-ride-services-through-one-screen/
5 https://itunes.apple.com/us/app/migo-the-ride-search-engine/id1174601220?mt=8
6 Ibid.

Integration with other apps



Migo has partnerships with a vast array of transportation services, including: Lyft, ReachNow, Seattle Yellow Cab, Zoro (Orange Cab and STITA Taxi in Seattle, Union Cab in Portland), Curb (Radio Cab in Portland), San Francisco Yellow Cab, LimeBike, SPIN, and Ofo. Currently Migo has not partnered with public transportation agencies; however, if their continuous expansion of their portfolio is a sign, Migo is seeking more transportation service company partnerships.

Multimodality

Pre-October 2017, Migo offered car-sharing and car-hailing as the only forms of transportation on their app platform. On October 12, 2017 Migo announced an expansion of their portfolio of ride partners with the release of a new mode of personal transportation, bike-sharing. Migo has partnered with bike-share innovators Limebike, Ofo, and Spin in Seattle, and Biketown in Portland. By dropping a pin on the Migo's map, users are now able to find bike-sharing options based on their location.[7]

Notification

The Migo app has quickly emerged as a leader in providing reliable information to customers, using GPS coordinates for all riding, walking, and waiting options.[8] Once in the Migo's app platform, user can enter a destination to get live price estimates for all of Migo's partners available in the area. By tapping a partner box, the user is shown transportation and special details. Furthermore, if car-sharing or bike-sharing, Migo provides navigation to those location, along with wait and walk times.[9] Much like the apps Migo partners with, Migo alerts the user when their mode of transportation has arrived and when payment has been received and processed.[10]

Waze

Background

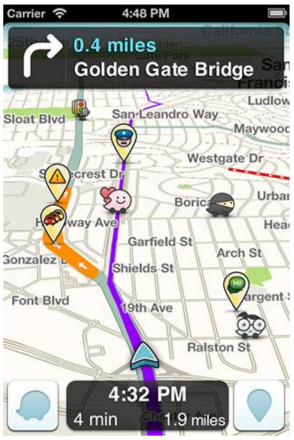
Waze is a free app, available on both Android and iOS, which is designed to help commuters navigate traffic by socially connecting users. Millions of people interact through the app on a daily basis. Users are able to update the app with many different traffic-related content so that other users can avoid those trouble spots.[11] For instance, if there is an accident that occurs in one person's location, the individual can click the app on the phone and make a warning comment in real-time. This allows commuters to reroute the path that is traveled in order to avoid these complications.

Data Collection

The app tracks a driver's traveling information when the app is enabled. This can be useful for everyone connected because it can provide real-time backed data.[12] The best route can mean avoiding traffic or accident delays, so the software uses the data collected from other connected users and provides a clear estimated trip time. The system will use the data to select an optimal route to travel.

7 *https://www.getmigo.com/news/articles/pr-newswire-october-12-2017-migo/*
8 *https://smartcitiesworld.net/news/us-cities-get-smarter-with-on-demand-rides-2060*
9 *http://www.govtech.com/applications/App-Connects-to-Multiple-On-Demand-Ride-Services-Through-One-Screen.html*
10 *https://www.geekwire.com/2017/migo-launches-transportation-search-engine-app-lyft-car2go-payment-integration/*
11 *https://www.waze.com/about*
12 *https://www.waze.com/carpool/index.html*

Event Integration



Users are able to make notes about various warning signs on the road. The warning signs include the following: accidents, construction, police traps, and any other potential traffic related issues.[13] This social aspect of commuting allows end users to say thank you, which provides a better experience for everyone involved. More users will want to use the app because of the impact their feedback creates.

Carpooling

The Waze app allows users to schedule carpool events as well. The Waze app allows people to connect with others in their local community and schedule pick-up times. This part of the app is in a premature stage; it is currently available across the state of California, but is limited to users that participate.[14] Carpooling reduces vehicle congestion, which benefits everyone on the road.

Government Integration

Waze began the Connected Citizens Program (CCP), which is a way that the company can report real-time data to government agencies to aide in city planning. For instance, the city of Boston has partnered with the CCP in order to reduce congestion and help reduce the delay surrounding common roadside problems. According to Marty Walsh, the Mayor of Boston, the partnership brings data from over 400,000 commuters on a daily basis.[15] Each city is unique, but the details in the data can help civil engineers create a better experience for drivers.

Service Integration

Waze is a free app that can be downloaded on multiple platforms, but they have integrated ordering platforms for things such as coffee. Waze and Dunkin Donuts have partnered up to allow Waze app users to click on the nearest Dunkin Donuts location and order products ahead of time.[16] This will decrease commuters overall travel time since they do not have to wait in a long line to order their coffee; it is already prepared and ready for pickup.

Partnerships

Recently, Waze has entered into a partnership with Spotify in order to gather more users, but also to provide a better experience for its current users. Waze participants, with the iOS platform, now can listen to their favorite playlists from Spotify while they are connected to the Waze app.[17] Since the app needs to be open in order to draw data, this is a great way for the consumers to listen to their playlist at the same time.

The ride-hailing app Lyft has an agreement with Waze and has implemented the app into its business model. This agreement allows Lyft the ability to access all of the road data available to the connected commuters.[18] Lyft now can navigate the roadway with the same suggested routes as consumers, which will allow them to provide an efficient ride experience for its passengers.

13 *https://support.google.com/waze/answer/6078702?hl=en*
14 *http://money.cnn.com/2017/05/31/technology/waze-carpool-california/index.html*
15 *https://www.cityofboston.gov/news/Default.aspx?id=18994*
16 *https://news.dunkindonuts.com/blog/wazeorderahead*
17 *https://finance.yahoo.com/news/spotify-waze-partner-bring-music-091547822.html*
18 *https://finance.yahoo.com/news/next-time-lyft-look-waze-233326294.html*

Multimodality

The Waze app only works for drivers and their passengers; it does not have a bicycle or walking integrated platform available at this time.

Notifications

Notifications can be scheduled on an integrated calendar within the app itself. When an end user has a specific time they want to leave for an event, they can elect to have a notification sent to their phone.[19] Other notifications include the GPS functions that let the commuter know when to turn, and when they are arriving at their destination. The system will also notify the user if a new traffic warning becomes available on their route.

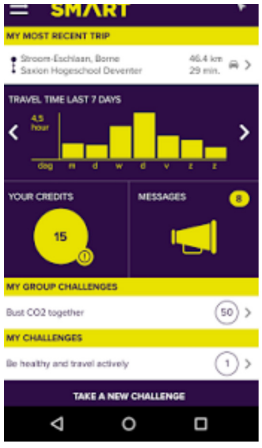
SMART Urban Mobility

Background

Mobidot, creator of the SMART Urban Mobility app, is an information and communications technology company based in the Netherlands.[20] Originally part of the European FP7 research program, Mobidot is a spin-off that supports intelligent mobility solutions and personalized mobile services to top level and end-users.

Top Level Users

The back-end goal of the SMART Urban Mobility app is to measure and analyze the travel behavior of users.[21] Taking advantage of GPS chips, Wi-Fi data, gyroscopes, and accelerometers in people's phones, precise data can be collected directly from users. This data can then be used by governmental authorities, transport companies, employers, or event organizers to solve transport and traffic bottlenecks in an alternate way. SMART allows top level users to influence end users with financial rewards, intrinsic motivation, and gamification.[22]



End Users

The SMART app lets end users set mobility goals and gain points.[23] The points are rewarded based on how hard the task is, such as traveling by bike 10,000 km compared to 5,000 km, and by its dynamic direct impact. The direct impact can come from activities such as using public transportation during rush hour or walking on hotter days, when smog is a bigger concern. The points can then be utilized in a webstore to purchase goods and services from participating merchants.[24] Even though the app is available to download worldwide, the partner merchants are currently all from the European Union. Due in part to this, gamification is also a large part of the app. Users can compare their points to their friends, regionally, and worldwide. The SMART app website has a leaderboard so you can show your dedication to the world.[25] The app also allows you to calculate how much CO_2 you have personally avoided by making more ecological transportation decisions. This information can be displayed using different timeframes and graphing options.[26] You can directly share this information on Facebook and Twitter.

19 *https://support.google.com/waze/answer/7502125?hl=en*
20 *http://www.mobidot.nl/en/about_mobidot.php*
21 *http://www.mobidot.nl/en/service_mon.php*
22 *http://www.mobidot.nl/en/tools_approach.php*
23 *http://www.mobidot.nl/en/service_behaviour.php*
24 *https://www.smartintwente.nl/*
25 *https://www.smartintwente.nl/leaderboard*
26 *Information from direct experience with app*

Event Integration

Mobidot allows top level users to create events that target specific regions.[27] This can be as broad as having a whole US state try to walk during lunch or as specific as rerouting your journey away from a concert. Becoming a top level user is not free, however, once you have access to the app you can create and manage as many events as you like. There is a cost to assign points to your event but this information is not publicly available.

Payment Integration

End users do not need to enter any payment information into the app. The points generated by the app can only be used on the specific SMART Urban Mobility webstore. The web store currently has a relatively small selection of merchants, and is European focused.

Integration with other apps

Top level users can use the data collected from the app in any subsequent apps they produce.[28] Mobidot releases their API to developers for this purpose. There is currently no direct integration with any other apps. The only outside links provided in the app are to post your information to Facebook or Twitter. This is a one-way information dump.

Multimodality

Goals and events set by top level users can be focused around multimodality. The app only differentiates modality based on vehicle type, so there is no difference between driving a personal vehicle or taking an Uber. Users have mixed reviews when it comes to the accuracy of being on a bus as compared to in a car.[29] Standing on public transportation is the user suggest best way to receive proper credit. While encouragement is giving to end users to use more ecological transportation options, multimodality is not a specific goal. There is also no information given to a user on how to acquire alternate modes of transportation; that research must be done independently by the end user.

Notification

24-hour real time data is collected from users of the app, unless they specifically turn off recording.[30] Top level users can access this data, also in real time, for their own discretionary use. Events or goals that are published can push notifications to users based on location. Cities or private event planners could use this to help mitigate traffic issues.

Individual Third-Party Apps

Ride-Hailing Apps

Lyft: The app is very convenient because it automatically withdraws payments when the ride is over. Lyft is trying to increase efficiency so it partnered with Waze to gain their real-time traffic warning data. Also, Lyft's app provides users with estimated pick-up times so that commuters are informed and ready.

Zoro: Users have the ability to look at a map on the application and reserve a taxi in their area. Commuters always know which taxi is theirs because the app indicates the vehicle number after the reservation is confirmed.ReachNow: Users can use the app to locate cars nearby with GPS location. ReachNow allows them to unlock a car with their phone or ReachNow card. Additionally, ReachNow allows users to pay by the minute, by the hour, or by the day. ReachNow is currently beta testing a ride-hailing product line.

27 http://www.mobidot.nl/en/service_behaviour.php
28 http://www.mobidot.nl/en/tools_approach.php
29 https://itunes.apple.com/mx/app/smart-urban-mobility/id1180519195?l=en&mt=8
30 http://www.mobidot.nl/en/service_mon.php

Bike-Sharing Apps

Biketown: This app is exclusive to Portland, Oregon. Users have three options to rent bikes: they can pay per trip, buy a day pass, or purchase a monthly pass. The company requests the bicycles be returned to Biketown stations, or any bike rack for an additional fee.

Sobi: Bicycles can be rented within select cities and dropped off at any bicycle rack in a designated area. In order to access the bike, there is a unique pin that is provided by the app, that must be entered. The app compiles data about the users routes, statistics, and mileage.

Ofo: This app allows users to rent a bicycle for only one dollar per hour. The bicycles have a scan code that is verified through the app. The company prefers that the bike be returned to a Preferred Parking Zone, so that they do not become a distraction to pedestrians.

Limebike: Users can rent a bicycle through the app and drop it off anywhere that bikes are legally able to park. There is a built-in lock on the back of the bike that is easy for anyone to lock and unlock. The app allows the user to find bikes using GPS location.

Summary

Waze, Migo, and SMART Urban Mobility each have unique approaches to integration and multimodality. Waze focuses on sharing peer data directly with other users. Migo allows individuals to directly compare transit options in one app. SMART Urban Mobility focuses on rewarding behaviors that benefit everyone. Ride-hailing apps, such as Lyft, Zoro, and ReachNow all have functionality that provide customers the opportunity to pay through their apps and get to their proper destination. Bike-sharing apps such as Biketown, Sobi, Ofo, and LimeBike allow users to rent a bicycle within their location, and drop it off at a location they are trying to get to. Each app is willing to collect and distribute data, all but with a cost of entry to top level users. While the focus may differ between these main apps, their ultimate goals are to bring increased efficiencies into the transit market.

TriMet has a lot of opportunity with multimodality to create a more efficient and convenient commute. Consumers are more likely to use multiple forms of transportation if they have the opportunity to access and pay for them through one easy to use app. An example of this is Migo; with this app, users can book a ride with Lyft, without even closing the app, or find a bike to rent in the destination area. Another move to provide more convenient travel is the carpooling opportunity within the Waze app. Currently, Waze allows users to arrange a time to commute together in select markets. The SMART Urban Mobility app alerts users of upcoming events so that they can plan their travel route around these congested areas.

TriMet has an opportunity to work with these apps by providing their data. There is a potential for users to be able to ride the light rail and rent a bicycle on their way to work, all by reserving through one simple and easy to use application. Multimodality is the future of travel and TriMet could consider joining in the movement early so that it can provide a benchmark for other public transportation entities.

Annotated Bibliography of Urban Mobility Consumer Behavior Research

Team 6:
Stacia Betley • Duran Brandon
Sohee Kim • Tim Gorman

Executive Summary

We compiled an annotated bibliography focusing on three main areas: the determinants of mode choice, how individuals respond to the new presence of shared-use mobility, and how mode choice changes based on different socioeconomic factors. Within these questions, some topics covered included: how incentive options play a factor in ride choice and how the negative aspect of public transportation is being lifted with the rise in shared-use mobility. The hopes of this annotated bibliography is to help other groups find relevant sources for their particular topics and to strengthen their case for different mode options.

Methodology

Our team first searched academic databases to find research papers on urban mobility and behavior research. Databases used were Academic Search Complete, JSTOR, and Sciencedirect. Keywords used for base search are mobility choice, mode choice, ride-sharing, incentive, mode choice behavior, travel behavior, travel pattern. First, 135 research papers were gathered. This was narrowed to 13 papers using the following criteria: closeness to class material and discussion, location the study was conducted, and time period the study was conducted. If a paper was too far from class material, it was removed from the paper. Also, if the research was not conducted in an urban setting, it was excluded. Finally, if a paper was not published in recent years (within five years), it was discarded. However, after a meeting with TriMet, as per their request, one paper was included that was conducted 10 year ago.

Q1: What are the main determinants of mode choice?

When answering the question of main determinants of mode choice, there was a wide array of studies that explored various factors in mode choice including: physical environment and urban mode factors, trip characteristics (cars are most often used for shopping trips), presence of Travel Demand Management (TDM), and psychological factors. One study found that people only choose the fastest option of mode about 43% of the time, and other times are motivated by something other than speed. Overall, the results indicate that passengers' perceptions of reliability and comfort play a bigger role than perceptions of availability and safety. In addition, research suggests that having a discounted transit pass increases the odds of alternative modes of transportation, while holding a parking permit reduces those odds.

Salonen, M., Broberg, A., Kyttä, M., & Toivonen, T. (2014). Do suburban residents prefer the fastest or low-carbon travel modes? Combining public participation GIS and multimodal travel time analysis for daily mobility research. Applied Geography, 53, 438-448. Retrieved from http://www.sciencedirect.com/science/article/pii/S0143622814001465

The article studied residents of Kuninkaankolmio, a suburb of Helsinki, to see what mode they chose for different types of journeys. Mode choices were classified into three categories: car, non-motorized vehicle, and public transportation. For each trip, an "optimal" mode choice was decided based on speed. The mode choices were then ranked based on carbon intensity with car being the most intense and non-motorized vehicles the least. The study looked at how often people took the "optimal" choice and how often they had different motivations. People most often chose a car, even when it was not optimal, for shopping trips. People most often chose the non-motorized or public transport option when it was not optimal for exercise/outdoor activities or to go into the city center, respectively.

This article helps to answer what determines mode choice. It shows that people only chose the fastest option 43% of the time. Though the article doesn't dive deep into the psychological

motivations that drive mode choice, it provides data on how mode choice relates to the type of trip that people are taking. This could be helpful in deciding where bike/walking paths or public transportation would be most useful.

Zhou, J. (2017). Sustainable commute in a car-dominant city: Factors affecting alternative mode choices among university students. Retrieved 15 November 2017, from http://www.sciencedirect.com/science/article/pii/S0965856412000651

This paper discusses the factors that affect alternative mode choices among university students in Los Angeles. Two main points of the paper include: commute distance being positively related to carpool and telecommuting, and those living alone are more likely to commute by driving alone than other students. Some other factors including gender, status (graduate vs. undergraduate), and age significantly correlated to walking, biking, or public transit. It was concluded that having a discounted transit pass increases the odds of alternative modes of transportation, while holding parking permit reduces those odds.

This paper helps to answer the determinants of mode choice, in addition to how mode choice is changing depending on demographics. It lays out multiple factors in mode choice, including: physical environment and urban mode factors, mode-specific factors, trip-maker's personal attributes, trip characteristics, presence of Travel Demand Management (TDM), and psychological factors. The paper recommends public policy strategies be implemented focused on environmental beliefs.

Hu, X., Zhao, L. and Wang, W. (2015). Impact of perceptions of bus service performance on mode choice preference. Advances in Mechanical Engineering, 7(3), p.168781401557382. Retrieved from http://journals.sagepub.com/doi/abs/10.1177/1687814015573826

This study examines what determines passengers' perception and the relationship between the role of such perception and travel mode choice. The data was collected by a survey in Nanjing, China. The survey included questions on characteristics of the travelers, perceptions of bus service level, and travelers' mode choice intentions.

The results of the study indicate that passengers' perceptions of reliability and comfort play a bigger role than perceptions of availability and safety. The perceptions of poor reliability pushed passengers to other modes – private cars and subways. Improvements related to bus service reliability and comfort are service frequency, ensuring on-time performance, and enhancing travel comfort. This result implies that passengers' perception should be considered when planning for shared-use motilities. The more reliable and comfortable the shared-use mobility is, more likely people will choose that mode choice.

Fu, X., & Juan, Z. (2017). Understanding public transit use behavior: integration of the theory of planned behavior and the customer satisfaction theory. Transportation, 44(5), 1021–1042. Retrieved from https://link.springer.com/article/10.1007/s11116-016-9692-8

This study uses the theory of planned behavior and the customer satisfaction theory in order to predict retention of current transportation passengers as well as how to attract new users in the future. An integrated framework is developed in order to investigate the psychological factors and mechanism underlying individuals public transit use decision.

This study helps us to answer what are the determinants of mode choice. The study

determined that intangible services (convenience, safety, and comfort), information (lines and schedule), and cost all factor into public transit use behavior. The perceived quality of intangible services directly influences the customer's satisfaction, behavioral intention, and habit. The lower the perception of cost, the stronger the intention to continue to use the mode. Perceived availability of information had a small impact on satisfaction.

Q2: How do individuals respond to the presence of multiple new mode options, such as ride-hailing/ride-sourcing and other shared-use mobility?

There are limited resources on how individuals respond to ride-hailing/ride-sourcing services due to these mode options being a fairly recent occurrence. From the studies that have been conducted, the research delves into why individuals gravitate towards these newer forms of ride-hailing/ ride-sourcing. The main factor is the ease of use and found those who use these services often own less privately-owned vehicles. In addition, it was determined that the use of ride-hailing services such as Uber or Lyft actually detracts people from using public transportation, biking, and walking. The studies conclude that ride-hailing services are most likely adding to, not reducing traffic congestion in major cities and it will take coordination between cities, public transit agencies, and ride-hailing services to address the issue.

Sorkin, M. (2017). The Autonomobile and the City. Architectural Record, 205(4), 64-72.

The article discusses the momentum that ride-hailing and ride-sharing apps are bringing to the autonomous vehicle race. Ride-hailing-apps make trips nearly entirely automated in the sense that computers organize the pickup, drop-off, and payment. The only item left to go completely autonomous now is to remove the driver. Autonomous vehicles, or automobility as the article calls it, could lead to a brand-new model of on-demand, point-to-point mobility, and have a major impact on urban streets. Once automobility is reached, a discussion can occur regarding the freeing and reappropriation of the urban streets to utilize the space it its fullest.
This article answers what determines mode choice, which according to the article is ease of access. As public transportation is not one of the more viable options in the United States, close to 90 percent of daily trips are by car. Automobility paves the way for many social benefits including eased mobility, reduced pollution, as well as accident reduction.

Mishra, G., Clewlow, R., Mokhtarian, P. and Widaman, K. (2015). The effect of carsharing on vehicle holdings and travel behavior: A propensity score and causal mediation analysis of the San Francisco Bay Area. Research in Transportation Economics, 52, pp.46-55. Retrieved from http://www.sciencedirect.com/science/article/pii/S0739885915000542

This study was conducted to examine effects of car-sharing behavior in the San Francisco area. The study divided people into two groups: car-sharing members and nonmembers and then compared travel behavior of the two groups. The results showed that car-sharing members held a lower number of vehicles than nonmembers when comparing the two groups with similar characteristics in demographics and environmental features. The study also found that members are likely to walk, bicycle, and use public transit more frequently than non-members.
The studied answered the question that when more car-sharing programs are offered, people are likely to choose the programs and hold less privately-owned vehicles. The study was conducted in San Francisco where a lot of commuters move during traffic hours and is considered as a highly populated area. This implies that car-sharing programs can bring similar results to other cities.

Clewlow, R. (2017). New Research on How Ride-Hailing Impacts Travel Behavior. Planetizen. Retrieved from https://www.planetizen.com/features/95227-new-research-how-ride-hailing-impacts-travel-behavior

The article discusses how there has been a severe lack of data on how, when, and why people use ride-hailing services. A recent study by UC Davis Institute of Transportation Studies determined that the use of ride-hailing services such as Uber or Lyft actually detract people from using public transportation, biking, and walking.

This study answers the question of how individuals respond to the presence of ride-hailing services. It concludes that ride-hailing services are most likely adding to, not reducing traffic congestion in major cities. Sharing vehicles is not enough to address the urban transportation issues. It will take coordination between cities, public transit agencies, and ride-hailing services to address the issue. Please refer to the article for more data, facts, and figures on ride-sharing.

Dudley, G., Banister, D., & Schwanen, T. (2017). The Rise of Uber and Regulating the Disruptive Innovator. The Political Quarterly, 88(3), 492–499. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/1467-923X.12373/full

The article discusses the rise of Uber in London. Uber combines technology with a 'sharing economy' allowing for more efficient matching of supply and demand than for traditional taxi services. It can be an important creator of jobs in a city, however also a destroyer of jobs. The existence of the black cabs is being questioned, which will take a toll on London's identity. In order to be a black cab driver, individuals spend up to four years of learning London's 25,000 streets, however Uber drivers only need access to satellite navigation systems. The driver training schools have an unknown fate, blaming competition from Uber. Uber drivers are also unsatisfied as they seek to be official company employees with the associated benefits and Uber takes 25% commission on each ride. Overall, the article concludes that Uber may harm local employment and creates problems for regulators.

Rather than examine consumers response to new mode services, this article addresses how Uber drivers, taxi drivers, and politicians responded to Uber in London. It states that innovation disruptors, like Uber, not only change models of business and employment, but also urban planning issues and patterns of mobility. The ability of Uber to undercut the taxi operations has caused fierce opposition in many countries. In addition, Uber has made regulatory regimes appear ineffective. Although Uber provides cheap and efficient service that is popular with consumers, it creates political dilemmas for regulators and governments.

Posen, H. A. (2015). Ridesharing in the Sharing Economy: Should Regulators Impose Über Regulations on Uber?. Iowa Law Review, 101(1), 405-433. Retrieved from http://web.a.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=14&sid=bf0dd2ff-f398-46a6-a719-14938b96f9fd%40sessionmgr4008

The article discussed the rise of the shared economy where more customers have the ability to use commodities and/or services that they would not normally be accustomed to. The article discussed multiple topics, including: how technology paved the way for ride-hailing apps, the shift in mindset from individual car ownership to a shared economy, as well as regulation. The article summarizes why individuals gravitate towards these newer forms of ride-hailing/ride-

sourcing transportation. Advances in technology have paved the way to make services like transportation an easier experience.

Q3: How is mode choice changing depending on key individual and household characteristics, such as income, residential land use setting, the presence of children in a household, and other factors?

There are multiple characteristics that are factors in mode choice. In the majority of studies presented, demographics examined include: age, gender, nationality, rural/urban living environment, who the individual is living with, high/low socioeconomic status, vehicle license, relationship status, and fitness level. Studies determined men were more likely to bike and women were more likely to take private vehicles or public transport, specifically the city bus. Those who identified themselves as single were also more likely to take public transport. Working young adults were more likely to commute by car and least likely to take active or public transport. Those with higher education and income most often use private vehicles and subways, and the larger the household size the more likely families use private vehicles. Those that take the subway have a higher chance of exercise. Another study showed that incentives affect passengers' mobility choice and is most effective during busy hours. Other studies examined the relation between public health, walkability, and public-school transportation to mode choice.

Duncan, D., Méline, J., Kestens, Y., Day, K., Elbel, B., Trasande, L., & Chaix, B. (2016). Walk Score, Transportation Mode Choice, and Walking Among French Adults: A GPS, Accelerometer, and Mobility Survey Study. International Journal of Environmental Research and Public Health, 13(6), 611. Retrieved from http://www.mdpi.com/1660-4601/13/6/611/htm

This article discusses a system of measurement called WalkScore, which determines walkability of an area. WalkScore divides facilities into five different categories: educational, retail, food, recreational, and entertainment. It then assigns a point score to each of these categories relative to their distance from a home, with the highest score going to facilities that occur within 0.25 miles from a home. The data in this article tracked the distance that people walked and compared it to the WalkScore of their neighborhood.

The measurements discussed in this article could be useful data when designing the urban areas of the future. Although it may seem obvious that people who live in walkable areas are more likely to walk, the conclusion states the importance of defining a walkable neighborhood. WalkScore is a model that grades neighborhoods by how walkable they are based on the categories of facilities that are in the neighborhood that they live in.

Tajalli, M. and Hajbabaie, A. (2017). On the relationships between commuting mode choice and public health. Journal of Transport & Health, 4, pp.267-277. Retrieved from http://www.sciencedirect.com/science/article/pii/S2214140516302365

The study examined the relationship between commuting mode choice and public health (obesity, blood pressure, and diabetes) using samples from New York City. The study found that if commuting mode is changed to taking the subway or walking from using private vehicles, the probably of obesity and other indicators of health significantly decrease. However, it was also found that changing behaviors from using personally owned vehicles to taking the city bus decreased the probability of obesity. Additionally, test results indicate that working from home

and not commuting is associated with a high probability of mental disorders from being isolated from social activities.

The results indicate that moving to public transportation improves public health by decreasing obesity, blood pressure, and diabetes. Some of the key takeaways, included: commuters who use private vehicles and the subway are associated with a higher level of education and household income, female respondents are linked to a higher probability to choose public transportation, and individuals who use the subway are often exercise more than those that do not. The results demonstrate why using the city bus shows negative impact on public health because groups that are likely choose city bus have exogenous factors that are related to obesity.

Schwanen, T., & Mokhtarian, P. L. (2005). What affects commute mode choice: neighborhood physical structure or preferences toward neighborhoods? Journal of Transport Geography, 13(1), 83-99.

This article surveys residents of different neighborhoods in and around San Francisco to see the extent to which mode preference influences neighborhood choice, and how much neighborhood choice affects mode choice, and then compares them. The result of the data is that the influence of travelers' environments is more powerful than their preferences. This article effectively reviews the relevant literature up to date and is summarized in the introduction.

This article answers the question of how mode choice changes based on peoples' lifestyles. The convenience of public transportation or commuting by bike greatly outweighs people's predispositions towards mode choices.

Simons, D., De Bourdeaudhuij, I., Clarys, P., de Geus, B., Vandelanotte, C., Van Cauwenberg, J., & Deforche, B. (2017). Choice of transport mode in emerging adulthood: Differences between secondary school students, studying young adults and working young adults and relations with gender, SES and living environment. Retrieved 15 November 2017.

This Belgian study targeted three groups of emerging adults, including: high school students (17-18 years old), college students (18-25 years old), and working young adults (18-25 years old). The study investigated different mode choices, walking, biking, driving and public transport dependent on gender, socioeconomic status and living environment. The study method included an online questionnaire completed by 1,307 adults.

The study includes 16 different factors including: age, gender, nationality, rural/urban living environment, living with parents, living with a partner, living with children, high/low socioeconomic status, driver license car, driver license moped, owning a car, owning a moped, owning a bicycle, public transport pass, bicycle sharing pass, and km to school/work. The conclusion stated that men were more likely to bike but less likely to commute by car than women; working young adults were most likely to travel by car and least likely to use active and public transport; and adults identifying with high socioeconomic status were more likely to travel by car than those with low socioeconomic status.

Kotesky, T. (2017). Uber, But for School Buses. Reason, 49(3), 10-11. Retrieved from http://web.a.ebscohost.com/ehost/detail/detail?vid=6&sid=2aaeca34-7a4f-4908-ba97-7345d410df22%40sessionmgr4007&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=aph&AN=123047941

This article discusses the possibility of ride sharing becoming a replacement for traditional modes of school transportation. The article analyzes the Success Express Program that was developed in Denver, Colorado. This program helped bus students to schools they were enrolled in outside of their typical residential districts letting them attend schools they might not otherwise have a chance to attend. It bypassed the lack of transportation infrastructure that was currently in the city and gave students a better educational option, made parents' lives easier, and also promoted innovation through change.

This article describes how mode choice is changing for households that do not have traditional access to urban school transportation for children to utilize. In adding additional methods for children to get to school, it opens the door for children to go to schools where they would not normally be able to attend. This gives them the opportunity to gain a better education that they would not normally be provided due to where they lived.

Qian, X., Zhang, W., Ukkusuri, S. V., & Yang, C. (2017). Optimal assignment and incentive design in the taxi group ride problem. Transportation Research Part B: Methodological, 103, 208-226. doi:10.1016/j.trb.2017.03.001. Retrieved from http://www.sciencedirect.com/science/article/pii/S0191261516306166

The study looks at taxi group rides, which allow people to form a group and share a ride in the format of a taxi. The study was conducted with data from New York City, Wuhan, and Shenzhen (China). The study went over two questions: how to optimally form a passenger group and how much incentives should be provided to passengers and drivers to maximize the benefits.

To answer the second question, they analyzed how the reduction rate of total mileage may vary based on different amount of incentives. Overall, the amount of incentives will not only affect the choice of passengers, but also determine the willingness of drivers to offer rides. As the incentive changes, passengers offered a lower trip rate are more motivated to share rides with other passengers, which results in more feasible rides and a more effective taxi group ride performance. However, sudden drops in reduction rate are observed when the trip fare discount goes below the threshold. Also, the study suggests taxi group ride plans would be more effective on weekdays and incentives should design and targeted such times. Their results in three cities indicate group rides were most effective during morning peak hours and evening peak hours on weekdays. During rush hour people frequently ride taxis for the last mile to reach or leave their place of work.

This study was performed in a taxi ride-sharing setting, but the implication can be applied to bicycles, privately owned vehicles, and other forms of public transportation. The implication includes designing incentive programs to optimize the benefits of ride-sharing for both passengers and drivers (or platforms). Incentives, in general, affect passengers' mode choice and are more effective if applied during busy hours.

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KOTESKEY, T. (2017). UBER, BUT FOR SCHOOL BUSES. Reason, 49(3), 10-11. Retrieved from http://web.a.ebscohost.com/ehost/detail/detail?vid=6&sid=2aaeca34-7a4f-4908-ba97-7345d410df22%40sessionmgr4007&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=aph&AN=123047941

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Schwanen, T., & Mokhtarian, P. L. (2005). What affects commute mode choice: neighborhood physical structure or preferences toward neighborhoods? Journal of Transport Geography, 13(1), 83-99.

Simons, D., De Bourdeaudhuij, I., Clarys, P., de Geus, B., Vandelanotte, C., Van Cauwenberg, J., & Deforche, B. (2017). Choice of transport mode in emerging adulthood: Differences between secondary school students, studying young adults and working young adults and relations with gender, SES and living environment. Retrieved 15 November 2017.

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Privacy and Security Issues in Urban Mobility

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Executive Summary

Transportation network companies (TNCs), innovative public transportation, and bike-sharing programs are revolutionizing urban mobility and the transportation industry. However, this has also introduced privacy and security issues associated with ride-sourcing apps and websites. For our project, "security" refers to the safety of personal information, such as credit card information or locational data, but not physical safety or transportation safety.

The privacy policies for the three segments of urban mobility that we explored were comparatively similar, but the most interesting difference was the use of location data collected from customers. Uber had a few notorious examples of data privacy violations, including post-ride tracking, fingerprinting of devices, and Uber's "God View." Other issues related to the sensitive nature of personal data are both intentional and accidental data breaches, selling of customer data to third parties by companies like Streetlight Data, and public complacency regarding the amount of personal information shared willingly by individuals.

With proper privacy and security measures, urban mobility data could be used for the greater good of the community. Big data has the potential to optimize urban planning and transit routes, and has broader implications for transportation policy. Uber Movement was a very tentative and superficial first step in the direction of government-mandated sharing of transportation data, but stronger policies could reveal the extent of vehicle miles traveled in cities by TNCs. This data could change public perception of the convenience of TNCs when weighed against the traffic congestion and additional emissions contributed by them. Additionally, data privacy groups like Electronic Frontier Foundation have created frameworks that could be used to evaluate the effectiveness of urban mobility policies.

Methodology

We researched what data is collected by transportation companies, how long that data is retained, and how they are using the data collected. Through our research, we found an expert in each of the three segments of mobility (TNC, urban public transportation, and bike-share). We conducted informational interviews with: Bobbi Kommineni, Vice President of Strategic Programs and Operations at Ride Austin; Dr. Jason Henderson, professor in Geography & Environment at San Francisco State and author of Street Fight: The Politics of Mobility in San Francisco; and Benjamin de la Peña, Deputy Director, Seattle Department of Transportation. After exploring the issues in data privacy and security and the implications for transportation policy, we created a framework to evaluate the effectiveness and transparency of existing privacy policies in the transportation industry.

Privacy Policies

Ride-hailing Companies

Uber's Privacy Policy[1]

Information collected by Uber includes customer-provided information (i.e. account information, payment or banking information, and address book or calendars synced to Uber's app), information provided by Uber drivers (i.e. account information, vehicle and insurance information, background check where applicable by law), and the information Uber collects from customers using their services (i.e. location, information submitted when contacting customer support, survey responses sent to Uber). Location data can be collected via GPS, IP address, or WiFi. Although location data makes it easier for drivers to pick up drivers, riders

1 *Uber Privacy Policy. (n.d.). Retrieved November 16, 2017, from https://privacy.uber.com/policy*

have the option to disable location information and request a ride by manually entering pick-up location instead.

Uber's privacy policy states that it uses this information to match drivers to riders, route planning, and for safety and security purposes. Pick-up/drop-off locations are shared with drivers, and Uber reserves the right to share customer information with their affiliates for legal reasons or a dispute. Uber's policy states that it does not rent or sell personal data that it collects. Riders can control the information that Uber collects by changing their privacy settings to limit Uber's access to location, address book, and calendar information, as well as opt-out of receiving promotional communication from Uber.

Uber has a team dedicated to data security and privacy who work to protect its data with encryption, authentication, fraud detection, and security software. Uber keeps customer information for as long as they have an Uber account. There is also a disclaimer that some information may be retained even after customers delete their account, such as data for legal requirements, payment issues, and data that is necessary for safety and security purposes.

Lyft's Privacy Policy[2]

Lyft collects similar user information as Uber. When riders sign up for Lyft accounts, Lyft collects basic account information like name and contact information, and Lyft gains access to Facebook friends if riders sign up using Facebook. Lyft does not store full credit card information on their servers for financial security reasons, but it does store payment information for drivers (ie. bank routing numbers, tax information). Lyft collects location information when the app is running, and may also collect location while the app is off if the user permission settings allow it. The information collected is used to connect riders with drivers, improve the Lyft platform, for marketing and promotional offers, prevent fraud, and for evidence in safety incidents and disputes. Unlike Uber, Lyft services are not available without location information enabled.

Lyft records usage information for app improvements and analyzes usage patterns from driver devices. If a rider calls customer support, Lyft's auto-recording will notify them that their conversation is being recorded for security purposes. Third party information collected by Lyft include enterprise programs (Lyft for Work) and background checks on drivers. Lyft's privacy policy also states that it may use aggregated customer information for company level negotiations with business partners.

Ride Austin's Privacy Policy[3]

Ride Austin collects information provided to them by the riders and through use of its application. Location information is collected either from the app or from customers' IP addresses. If riders disable the location information, Ride Austin may still be able to obtain their location using IP address and collect trip location information from drivers' devices. Ride Austin also collects information from server logs, which records information like pages viewed, system activity, and the service used prior to opening the Ride Austin app.

Ride Austin uses the collected information for data analysis, troubleshooting software bugs, and fraud prevention. It also uses the information to personalize its services, such as recommending features or advertisements based on customers' preferences. Ride Austin's privacy policy states that it will retain information "only for as long as is necessary to fulfill the business purpose it was collected," which is much more vague and unclear whether it retains information after a user deletes their account.

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2 Lyft Privacy Policy. (n.d.). Retrieved November 16, 2017, from https://privacy.uber.com/policy

3 Ride Austin User Privacy Statement. (n.d.). Retrieved November 16, 2017, from http://www.rideaustin.com/user-privacy-statement-2

Ride Austin shares user information with its marketing partners and law enforcement if necessary. In addition, Ride Austin shares information with research groups, such as University of Texas, for data analysis and research related to app usage and trip planning. Some research topics listed include surge pricing, customer wait times, and lowering rates.

TriMet's Privacy Policy[4]

TriMet collects various information about the customer through their website, mobile apps, and electronic fare cards. Along with personal information that they obtain when the customer interacts with the app or website, they also automatically receive location information, device details, and cookie data when the customer uses TriMet services.

TriMet aggregates and anonymizes personal information so that a customer cannot be identified individually to deliver relevant and responsive services. TriMet does not knowingly collect personal information from users under the age of 13. TriMet uses the personal information to communicate and provide customizable services to the customer.

TriMet does not sell, rent, or disclose personal information to any unaffiliated third party, with the limited exceptions of service providers, their transit partners C-TRAN and Portland Streetcar, and recipients who are entitled to the information for legal or safety reasons. TriMet may also share a customer's personal information for a promotional offering made by a third party or TriMet. These third parties have limited access to the customer's information only to perform these tasks on TriMet's behalf.

Bike-share Companies' Privacy Policies

Comparing the privacy policies of six major bike sharing companies (Social Bicycles, Capital Bikeshare, Citi Bike, Mobike, OFO, and Lime Bike) produced very similar results. When a user signs up for an account all companies collect standard personal information: first and last name, e-mail address, year of birth, username and password, telephone, and mailing address.[5] Companies seem to differ on what they do with credit card information. Some seem to handle the data directly and others go through third parties.[6] In those cases, when a customer is about to enter payment information the website redirects to a processing site and then sends the customer back to complete the rest of the transaction. When a customer is actively using their service (i.e. renting a bike), companies collect additional information. This information is about the mobile device: timestamp, OS name and version, location, device identification number, application version, device identifier, stored cookies information, and contacts information as well as the actual trip data.[7] Motivate Inc. (which operates both Capital Bikeshare and Citi Bike) and Lime Bike also make special reference to photos, reviews, and affiliated social media platforms.[8]

All policies made mention of sharing aggregated data with other entities for various reasons. Motivate Inc. specifically calls out municipalities and most of the others mention partners. All mention using your data for marketing research and most call out Google Analytics specifically.[9] Many of these companies post their anonymized data for public use. This data contains information like start and stop times, pickup and drop off locations, and often information on the individual bike used.

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4 TriMet Privacy Policy. (n.d.). Retrieved November 16, 2017, from https://TriMet.org/legal/privacy.htm
5 Mobike Privacy Policy. (n.d.). Retrieved November 16, 2017, from https://mobike.com/global/privacy
6 ofo Privacy Policy. (n.d.). Retrieved November 16, 2017, from https://www.ofo.com/privacy-policy
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9 Lime Bike Privacy Policy. (n.d.). Retrieved November 16, 2017, from http://www.limebike.com/privacy

Data Privacy and Security Issues

Within TNCs, the biggest difference in privacy policies is how the companies obtain and use rider location information. Uber sets the template for what not to do with customers' data. Uber has been severely criticized in recent years for violating the privacy of customer data and has therefore imparted valuable lessons, albeit unintentionally, to all other transportation companies including ride-hailing companies, public transit, and bike-share companies on how not to violate the trust that customers have placed in them by mishandling the vast amounts of personal data that they collect.

Uber has used some outrageous and sketchy methods in recent years to gain competitive advantage and were implementing these practices as recent as August of 2017, after which they had to update their company privacy policy due to incessant and severe criticism of their methods from all quarters.

Uber's Post-Ride Tracking of Users' Location

Uber implemented a controversial practice that allowed the ride-hailing app to track location of customers even when the application is running in the background.[10] Before this tool was used, Uber only collected user data when the app was open. But with this practice, Uber could collect location data even after the rider closes the app up to five minutes after the end of the trip, which meant Uber was trying to determine the end destinations of the customer. This forced customers to use an all-or-nothing location permission setting. If users decided to not permit the app to always track their locations, they would have to type out their location every time they hailed a ride, which is inconvenient because Uber's use of location sensors is what makes the app so convenient and easy to use. Uber's justification for this method was to help them improve pickup and drop-off locations and enhance customer service and safety but they received heavy backlash for this practice.

Hiding the Practice of Fingerprinting After Deletion of Uber App

Uber used a technique, known as fingerprinting, to identify iPhones even after customers had deleted the uber app or cleared their phone altogether.[11] When someone uninstalls an app that uses fingerprinting, it leaves behind a small piece of code that could be used as an identifier if the app is ever reinstalled on the device.This technique itself isn't uncommon and could be used in a non-invasive way to prevent fraud. But what was questionable was Uber still fingerprinting after the deletion of the app and trying to cover up what they were doing. This shady practice and their lack of transparency landed them in hot water with Apple, who rebuked Uber for crossing the line.

Uber Employees Having Access to All Personal Data

Former Uber employees criticized Uber for its handling of customer data which could lead to potential threats of hacking, blackmail and espionage.[12] Uber's cavalier handling of data led to the Electronic Privacy and Information Center (EPIC) calling for a federal investigation into Uber's data collection methods. One of the big issues was Uber employees having access to vast amounts of personal data, which they could misuse. However, Uber didn't really take

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10 Wamsley, L. (2017, August 29). Uber Ends Its Controversial Post-Ride Tracking Of Users' Location. Retrieved December 01, 2017, from https://www.npr.org/sections/thetwo-way/2017/08/29/547113818/uber-ends-its-controversial-post-ride-tracking-of-users-location

11 Newman, L. H. (2017, June 02). Uber Didn't Track Users Who Deleted the App, But It Still Broke the Rules. Retrieved December 01, 2017, from https://www.wired.com/2017/04/uber-didnt-track-users-deleted-app-still-broke-rules/

12 Evans, W. (2016, December 20). Why privacy advocates are worried about Uber's security problems. Retrieved December 01, 2017, from https://www.revealnews.org/blog/why-privacy-advocates-are-worried-about-ubers-security-problems/

any initiatives to restrict this. Instead, they just used a pop-up message warning employees not to abuse their access. This step, ultimately, did nothing to actually prevent employees from misusing this data. Finally, Uber was trying to address these issues in the latter part of 2017 by launching a differential privacy tool that facilitates analysis of large amounts of data without revealing the identity of any customer.[13] Only time will tell the efficacy of this tool in anonymizing and protecting individual user data.

Uber's "God View" Tool

Uber employees were accused of using a tool called "God View" to track the movements of politicians, celebrities, ex-boyfriends, and girlfriends.[14] This tool could track the movements of individuals in real time. Although Uber stopped using this tool a couple of years back when they got exposed, this shows the extent to which Uber employees went to violate the privacy of its customers.

Streetlight Data

The data being collected and either held or distributed by transportation companies is not the only way to track movement throughout a city. Tech companies like Streetlight Data have come into existence that take anonymized cell phone geolocation data and track the movement of people through space,[15] while companies like Sensity Systems are collecting informations from actual streetlight fixtures.[16] Streetlight Data services are for sale to both public and private consumers and used to make decision on everything from where to open the the next branch of a restaurant to whether or not to add an additional on ramp to the freeway. As an example, in Northern Virginia, Virginia Department of Transportation (VDOT) used Streetlight Data to identify ways to potentially reduce traffic by over four million short range trips through increased pedestrian and bike access in combination with circulator shuttles.

Sensity Systems is taking a different approach. They sell streetlights to municipalities and private businesses with embedded sensors. These sensors cover everything from temperature to the ability to take photo and video. The data is accessible by the owners of the lights but Sensity also sells the data to third parties. Sensity places a high value on privacy; their motto is "Security Without Surveillance."[17] For example, if a customer wanted to track pedestrian, bike, and auto traffic past its enabled lights, the sensors would record a count of each without actually storing any data on an individual person or car.

Public Complacency about Data Privacy

Privacy concerns in relation to location tracking are legitimate. Urban Mobility apps have become a focus for this conversation, however it is important to remember that this information is being tracked by a host of other entities as well. Apps like Google Maps or Waze use location data to provide navigation. Other apps require location data to enhance your user experience, this data is stored and/or sold for marketing purposes. Users "check in" to places and events on Facebook or post geotagged Instagram photos.

Another place that mobility data exists is within the vehicles themselves. Connected

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13 Conger, K. (2017, July 13). Uber Unveils New Privacy Tool That Protects Individual User Data. Retrieved December 01, 2017, from https://gizmodo.com/uber-unveils-new-privacy-tool-that-protects-individual-1796865515

14 Bacharach, E. (2017, October 04). Uber Has a 'God View' Tool and Was Allegedly Using It to Spy on Celebs. Retrieved December 01, 2017, from http://www.cosmopolitan.com/lifestyle/a8495499/uber-using-god-view-tool-to-spy-on-celebs/

15 Data, S. (n.d.). StreetLight Data | Privacy Principles. Retrieved December 01, 2017, from https://www.streetlightdata.com/streetlight-data-privacy-principles?hsCtaTracking=aef22474-40f3-4a06-8007-c57d1ed5d195%7C20652897-0b8b-49a2-94dd-57ece6301d80

16 Turning street lighting into a system for gathering Big Data. (n.d.). Retrieved November 18, 2017, from https://atelier.bnpparibas/en/smart-city/article/turning-street-lighting-system-gathering-big-data

17 Sensity Systems Focuses on Security Without Surveillance. (2015, May 5). Retrieved November 18, 2017, from http://www.sensity.com/pressrelease/sensity-systems-focuses-on-security-without-surveillance

vehicles capture a lot of information on users, including GPS location, radio station, speed, tire pressure, climate, cell phone use, etc. This information is held by the car companies themselves, although many consumers are choosing to share this data with other companies like insurance providers for better rates.[18]

In our interviews with Dr. Jason Henderson and Benjamin de la Peña, data complacency was a common theme. It seems likely that a public renegotiation around data privacy is on the horizon.

Implications For Policy

Ride Austin and Open Data

Ride Austin supports open data policy and publishes its data on data.world. The data include the amount donated to each charity supported by Ride Austin's Round Up program and information about individual rides, which have been anonymized. The ride data lists the total fare, rates, time duration of the ride, car description, and the rating of riders and drivers on a five-point scale. Although the data does include pickup or drop-off locations, it does not provide any other identifying information about the rider. It is free to make a login account on data.world and anyone can view Ride Austin's data.

Uber Movement – Changing the face of urban planning or a farce?

What is Uber Movement?

Uber Movement is a free tool that shares dynamic insights about traffic and mobility in cities where Uber operates. Its purpose is to help city officials and planners figure out how to improve their transit systems. The hope is that cities and urban planners can use the data to support projects that would help reduce congestion and generally help people get from point A to point B faster.[19]

What information does Uber Movement provide?

Currently, Uber Movement displays average travel times around and between various areas of available cities. The Uber Movement website shows how long it takes to get from one part of a city to another based on the day of the week and the time of day.[20]

Uber Movement's travel times are determined by anonymous trip data from Uber driver-partners completing trips around the city. To ensure privacy for everyone on the Uber platform, Uber Movement never shares any personal information about riders or drivers.

Why Uber Movement?

Uber has had a tumultuous relationship with city governments.[21] As the ride-hailing company had expanded its operations globally, it has jumped into fights over regulations that would curtail the scope of its activities. The latest battlefield was New York City, where Uber refused Mayor Bill de Blasio's demand that it share with the city data on when and where it drops off every passenger.

As a peace offering, Uber's response was introducing Uber Movement. This new service uses information on the billions of rides Uber has completed. It's free, open to anybody who wants to use it, and lets users track car travel times between any two points in a city at any time of day.

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18 Quain, J. R. (2017, July 27). Cars Suck Up Data About You. Where Does It All Go? Retrieved November 18, 2017, from https://www.nytimes.com/2017/07/27/automobiles/wheels/car-data-tracking.html

19 Mannes, J. (2017, August 30). Uber Movement traffic data finally makes it out of beta. Retrieved November 18, 2017, from https://techcrunch.com/2017/08/30/uber-movement-traffic-data-finally-makes-it-out-of-beta/

20 Let's find smarter ways forward. (n.d.). Retrieved November 18, 2017, from https://movement.uber.com/cities?lang=en-US

21 Davies, A. (2017, June 03). "Uber Movement" Is a Mildly Helpful Tool for City Planners and Data Geeks. Retrieved November 18, 2017, from https://www.wired.com/2017/01/uber-movement-traffic-data-tool/

Why is Uber Movement not effective at what it claims to achieve?

Uber's attempt to be a part of city planning appears to be nothing but a superficial olive branch offering to the government. The numbers that Uber is releasing are not the highly coveted numbers that cities need.22 It's a slight peek into their treasure trove of data that they possess but that's all it is–a peek from the outside.

What the cities really want to know from Uber and other similar companies like Lyft is when and where passengers get picked and dropped off. Uber's data release can be useful, but the level of detail and the type of data isn't something that's not already used by planners through other data sources. What planners really want to know is where people start and end most of their trips. Analyzing commute patterns results in better understanding of where to focus resources, whether it's improving roadways or building up public transit. However, Uber doesn't want to divulge propreitary data voluntarily. As a business, Uber wants to hang onto the competitive advantage they enjoy from collecting such valuable data. Hence any data that's made public that might reduce their competitive advantage is not very likely to happen. So, city planners shouldn't be optimistic about Uber's data releases.

Should Uber release data about its usage in different cities? Is Uber not delivering on its promise of reducing traffic congestion?

While Uber and Lyft have extensive data on their customers, both have been reluctant to share it. They are notorious for keeping this data private. Could there be another reason other the proprietary value of this data for Uber to not divulge this data. Is Uber not delivering on its promise of reducing congestion in cities? Is it actually contributing to the opposite? Studies performed with data acquired from multiple American cities provide evidence about Uber's negative impacts on urban congestion.

A study conducted by University of California Davis researcher Dr. Regina Clewclow found that ride-sharing car usage does not decrease the number of overall miles driven in cities.[23] Even though people aren't driving themselves, the number of car trips taken by them are still the same. The number of vehicle miles traveled (VMT) is expected to grow in the next few years. Some of the critical reasons for this increase in miles are that some people are choosing ride-hailing apps for their convenience even to cover shorter distances, which they would covered by walking, biking, or on public transit if ride-hailing apps didn't exist. Another reason is the increase in deadhead miles during which the ride-hailing drivers are still driving on the roads without a passenger.[24] Drivers also drive to the city by traveling long distances to get more passengers. So, while commuters enjoy the convenience that ride-hailing services provide, this could pose challenges for city planners.

This has forced lawmakers and researchers to seek other ways of trying to figure out the services' impacts.[25] San Francisco has gone to court in a pending case to demand information from the companies about their use of city streets. The city also commissioned its own study about Uber's and Lyft's impacts on congestion.

Does Uber owe it to the cities that they operate in to provide this data? If ride-hailing

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22 Finally, Uber Releases Data to Help Cities With Transit Planning. Retrieved November 18, 2017, from https://www.citylab.com/transportation/2017/01/finally-uber-releases-data-to-help-cities-with-transit-planning/512720/

23 Edelstein, S. (2017, October 12). Uber And Lyft Usage Increases Miles Driven In Cities, Study Says. Retrieved November 18, 2017, from http://www.thedrive.com/tech/15073/uber-and-lyft-usage-increases-miles-driven-in-cities-study-says

24 Study: Uber and Lyft Add Traffic, Reduce Efficiency on Denver and Boulder Roads. (2017, March 30). Retrieved November 18, 2017, from https://denver.streetsblog.org/2017/03/29/study-uber-and-lyft-add-traffic-reduce-efficiency-on-denver-and-boulder-roads/

25 Said, C. (2017, October 11). Uber, Lyft reduce transit use, increase vehicle miles, report says. Retrieved November 18, 2017, from http://www.sfgate.com/business/article/Uber-Lyft-reduce-transit-use-increase-vehicle-12267774.php

companies actually want to be a part of better city planning decisions for their own prosperity in the future, cities will require this data to make informed decisions about the future.

Seattle Department Of Transportation New Mobility Playbook

Seattle released their New Mobility Playbook[26] recently and it is a great example of taking an active role in shaping transit in this emerging space. While the Playbook takes a broad look at Urban Mobility in Seattle they do spend some time talking about data, particularly in Appendix D. They recognize the tension between public need and proprietary information, and call for a clear identified need for public data collection.

Electronic Frontier Foundation (EFF)

Purpose of EFF

EFF is a San Francisco digital rights group who is pushing sharing-economy companies to better protect user data. The group ranks companies based on how they respond to government requests for data, and companies that maintain data privacy receive a higher score. Uber and Lyft were the only two ride-hailing companies on the list and they both received perfect scores. Of the ten companies surveyed, Uber and Lyft were also the only two companies to issue public transparency reports (see Appendix Figure 1).

EFF focuses on tech advocacy and helps companies improve their privacy policies to protect against government requests for data.[27] To obtain data legally, the government should have a warrant for content and the company should inform users before disclosing their data to the government.

Privacy Topics

EFF has won historic legal cases involving privacy. For example, USA v. Pen Register is a case about government tracking cell phones without probable cause.[28] The government had been requesting permission from courts to conduct data tracking without warrants, which EFF believed was illegal and violated user privacy. Locational privacy is at risk with GPS transmitters and location-based service providers. EFF actively opposes law enforcement who illegally obtains this data and service providers who misuse locational data.[29]

EFF also believes that Do Not Track (DNT) signals issued by users should be respected by companies seeking to collect data, and companies should include an opt-out for users who do not wish to be tracked.[30] This includes TNCs collecting rider data via cookies for marketing purposes. There is a lack of transparency with cookie tracking that lets users be tracked without their knowledge. Fingerprinting, as in the case with Uber mentioned earlier, continues to follow people who try to delete their cookies, which is clearly an invasion of privacy.

Our Framework for Evaluating Data Privacy Policies of Emerging Urban Mobility Companies

Modeled on EFF's "Who's Got Your Back?" framework that evaluates how government requests for data are handled by companies, we created a similar set of criteria to evaluate

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26 Cory, E. (2017, September). New Mobility Playbook (United Stattes, Seattle Department of Transportation, New Mobility Program). Retrieved December 1, 2017, from http://www.seattle.gov/Documents/Departments/SDOT/NewMobilityProgram/NewMobility_Playbook_9.2017.pdf

27 Who Has Your Back? (2017, Jul 10). Retrieved November 18, 2017, from https://www.eff.org/who-has-your-back-2017

28 USA v. Pen Register (Cell Phone Tracking Case), EFF. Retrieved December 1, 2017, from https://www.eff.org/cases/cellphone-tracking-cases-usa-v-pen-register

29 Locational Privacy, EFF. Retrieved December 1, 2017, from https://www.eff.org/issues/location-privacy

30 Do Not Track, EFF. Retrieved December 1, 2017, from https://www.eff.org/issues/do-not-track

how urban mobility companies protect and use mobility data.

Data collection is important, and privacy concerns must be monitored. Regulations on how and what TNCs should or should not share can be handled at the local, state, or federal level. If data is shared between private companies and city governments, concerns about security, access, anonymity, aggregation, and usage need to be addressed. Using both historical and real-time data, public transit agencies can do a lot with the information provided by these private companies. Cities like Seattle and Austin are taking the necessary steps to proactively manage these relationships as well as identify the use cases for different kinds of data. Multimodal transport looks to be the way of the future and the more seamlessly the various modes can be combined, the more likely a portion of the trip will be public transit. With data integration comes increased risk of privacy and security concerns. Public entities need to be especially careful with the data entrusted to them. Data security is a dynamic field and emerging technologies like blockchain may offer methods of both sharing and securing data.

	Protects User Information	Protects User Location Data	Transparency in Data Collection	Transparency in Data Sharing	No Data Breaches in the Past 5 Yrs	No Data Privacy Violations in the Past 5 Yrs
	★	★	★	☆	☆	☆
lyft	★	★	★	☆	★	★
RIDE AUSTIN	★	★	★	★	★	★
	★	★	★	★	★	★
ofo	★	★	★	☆	★	★
LimeBike	★	★	★	★	★	★
sobi SOCIALBICYCLES	★	★	★	★	★	★

FUTURE DIRECTION

Appendix 1

Figure 1. Electronic Frontier Foundation Summary Chart for Sharing Economies[31]

31 *How Airbnb, Uber, and Lyft rank on privacy protections. (2017, Feb 24). Retrieved November 18, 2017, from https://www.dailydot.com/layer8/eff-who-has-your-back-report-2016/*

Appendix 2

Should Uber release data about the working conditions of its drivers?

Uber has received major criticism over the working conditions of its drivers and their refusal to divulge any of their driver data could have major implications for future policy decisions.

Uber's operations in London took a major hit after reports surfaced of them subjecting their drivers to harsh working conditions.[32] Although Uber classifies its drivers as self-employed, which puts them outside minimum wage legislation, Uber determines the working patterns of drivers once they have logged on, has increased its own commission while cutting the ride rates for the consumer, and imposes lockouts from its system if drivers turn down too many jobs. This, along with with high costs involved with the vehicles needed to meet Uber's requirements to be eligible to be a driver, results in low pay for drivers and insecurity about their jobs.

Uber firmly denied these claims but is it timely that these employee data be released to inform policy decisions for better working conditions for independent contractors like Uber Drivers.

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Urban Policy For Autonomous Vehicles

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Executive Summary

Although automation has been around since the late 1800's, sophisticated automated technology in vehicles is just beginning to come to market. However, rapid advancement is upon us. Just as private sector companies are competing for a leadership position in Autonomous Vehicle (AV) technology, governments are racing to develop innovative policy that addresses changes to infrastructure and revenue sources resulting from vehicle automation. The multiple levels of automation, varying strategic approaches to executing on this technology, and possible adoption scenarios complicates things even more for legislators and government agencies.

However, Oregon is taking a leadership position in this race. To ensure automated vehicle adoption is associated with transportation as a service and multi-modal transit, they are testing pay-per-mile tax and creating tools for residents to make informed mobility decisions. To take it a step further, TriMet can review the policies of other cities to find additional opportunities. This includes existing efforts to register Autonomous Vehicle testers in Nevada, cap additional parking spaces in Zurich, and partnerships with the private sector to develop a MicroTransit system in Los Angeles.

Taking into the account the current environment, existing policies, and future implications of this technology, additional planning is necessary to prepare for this disruption. This includes creating new budgets and tax schemes that account for lost revenue resulting from electrification (which affects the gas tax) and reduced need for parking (lowering municipal parking revenue). Also, implementing policy to encourage ride-sharing and multi-modal transit, such as implementing congestion tax and getting rid of parking minimums. Lastly, working with the private sector to provide seamless integration with automated vehicles and public transit. Subsidizing last mile rides and working with TaaS providers to integrate payment systems will move us toward the "best case scenario" – citizens accepting AV technology as a public service that increases opportunity for higher mobility in our cities.

History

Autonomous Vehicles

The dream of self-driving cars started long before the Defense Advanced Research Projects Administration (DARPA) Autonomous Vehicle (AV) challenges saw winners like "Stanley" and "Boss" navigate the Mojave Desert in a closed mock city without input from a human driver.[1] Technology for self-propulsion and automated steering could be found as early as the 1860's in the auto-tiller of a sailboat, the self-propelled torpedo and Mechanical Mike autopilot developed by Sperry Gyroscope Co. GM's Futurama exhibit at the World's Fair in New York in 1939, was a vision of an automated highway system, where drivers could switch to self-driving mode for stress-free highway travel.[2]

The first truly autonomous car was developed in 1977, by S. Tsugawa of Japan, operating on an elevated rail at speeds up to 30km/h. In the 1980s, Germany's Ernst Dickmanns started adding sensors and software, developing "Dynamic Vision" to allow recognition of road markings, lane position, and other cars. These advances moved research towards vision-based data processing, instead of signals or input from the roadway.[3]

Mainstream auto manufacturers have been slowly rolling out autonomous features like lane

1 Vanderbilt, Tom. 2012. "Autonomous Cars Through the Ages." Wired. 6 February. Accessed November 8, 2017. https://www.wired.com/2012/02/autonomous-vehicle-history/.

2 Weber, Marc. 2014. "Where to: A History of Autonomous Vehicles." Computer History Museum. 8 May. Accessed November 8, 2017. http://www.computerhistory.org/atchm/where-to-a-history-of-autonomous-vehicles/.

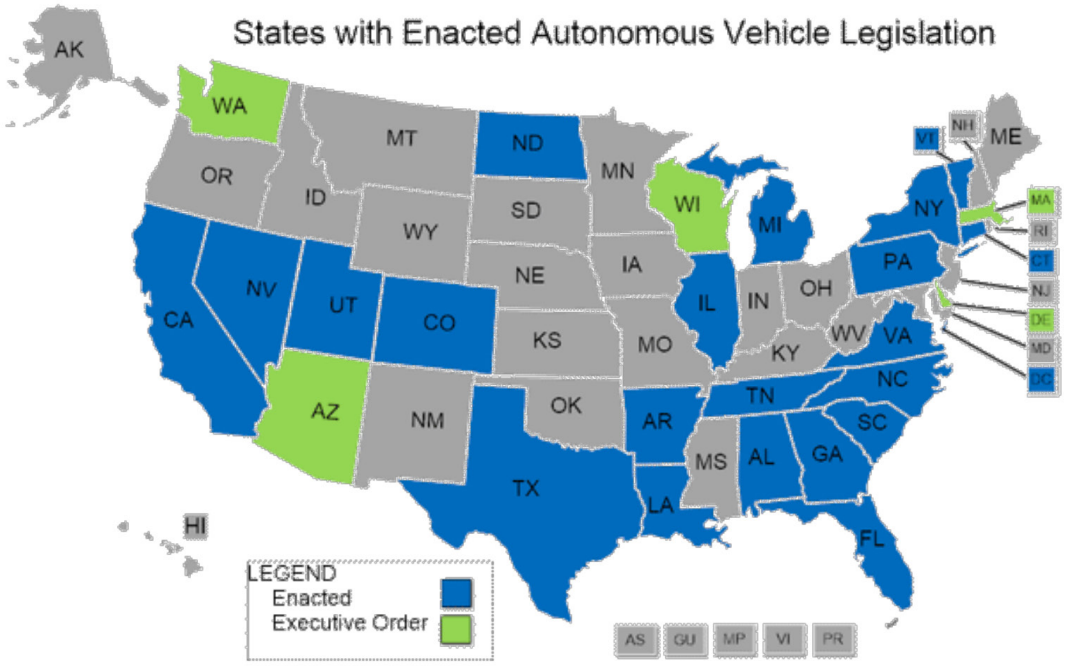
3 Wired Brand Lab. 2016. A Brief History of Autonomous Vehicle Technology. Accessed November 8, 2017. https://www.wired.com/brandlab/2016/03/a-brief-history-of-autonomous-vehicle-technology/.

and parking assist, and emergency braking. By 2015, Tesla introduced Autopilot, and delivered it to existing customers by an overnight software update.[4]

AV Legislation

As AV technology advances, federal and local government has been slow to respond. The uncertainty around timing and the type of changes AV technology will bring has focused existing legislation on safety. Federal action to date is primarily guidance, encouraging the development of technology with life-saving potential. A majority of U.S. states were considering legislation as early as 2012, and in 2017, 33 have enacted legislation (see Figure 1).[5] Most states are focused on rules for registering and/or testing of AVs. A 2016 study by Erick Guerra found few Metropolitan Planning Organizations are considering AV impacts in their long-range planning.[6]

Figure 1



The governors of several states have signed executive orders with directives for committees to develop rules and recommendations for preparation by transportation agencies, insurance, registration, traffic, AV operation, and testing. The City of Portland released the Smart Autonomous Vehicle Initiative (SAVI) in 2017. This initiative has five directives for the Portland Bureau of Transportation. They include: encouraging innovation and guiding development to meet the goals of the community, prioritizing fleets of AVs, and ensuring benefits to underserved and low-income communities.[7]

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4 Dormehl, Luke. 2017. "Sit back, relax, and enjoy a ride through the history of self-driving cars." Digital Trends. 2 November. Accessed November 8, 2017. https://www.digitaltrends.com/cars/history-of-self-driving-cars-milestones/.
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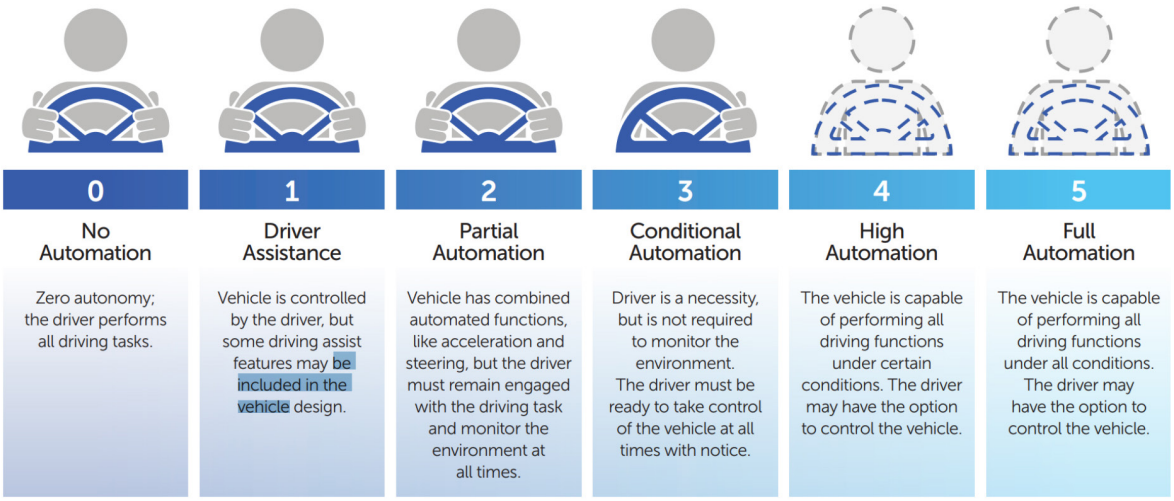
Current Landscape

Technology

The U.S. Department of Transportation (DOT) and National Highway Traffic Safety Administration (NHTSA) developed guidance for development and testing of autonomous vehicles that centers on safety. Within that guidance, the DOT defines autonomous vehicles based on a six level system (0-5) created by the Society of Automotive Engineers (SAE). At level 0 there is no automation in the vehicle and a human driver is required at all times to operate the vehicle, monitor, and respond to the surrounding environment. At level 2 the vehicle has an Advanced Driver Assistance System (ADAS) that includes a combination of automated technologies (steering, braking, acceleration). A human driver is still required to remain at full attention and in operation of the vehicle. By level 4, the Automated Driving System (ADS) can operate the vehicle as well as monitor the surrounding environment under certain circumstances without human input, but there is still the option for human operation. Level 5 is considered a fully automated vehicle where humans never drive and only carry passengers.[8]

Figure 2



Source: https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf

Players

Car manufacturers, internet companies, ride-sourcing apps–all are vying for a space in the AV market. Each are taking their own approach and are in different stages of development based on their stake in this market. As shown in Figure 3, most of the companies that are looking to be major players in the autonomous vehicle market are car manufacturers. GM has emerged as the leader of advancing autonomous technology for their cars and making prototypes to test on the roads. Through their subsidiary Cruise, they have been able to make autonomous versions of the Bolt that have some parts of level 4 automation. These cars have not fully reached level 4, but incorporate features that are able to monitor the surrounding environment and do most driving functions without driver assistance. GM also recognizes the importance a backup system to take over in the event that components, like the braking system, fail. They innovated solutions that are independent of each other so if one fails, the other is unaffected.

8 *U.S. Department of Transportation. 2017. "Automated Driving Systems 2.0 A Vision for Safety." September. Accessed November 25, 2017. https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf.*

This technology is similar to airplanes that have several layers of backup that run on independent power sources so the aircraft can have failing parts and still operate safely.[9]

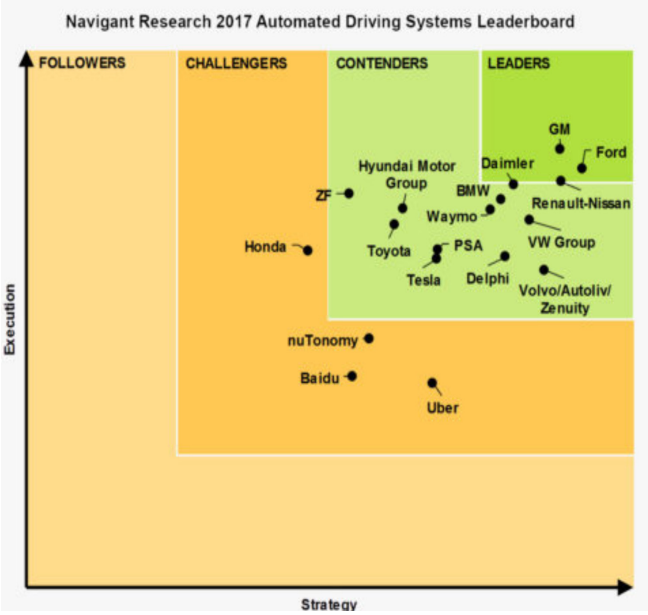
Tesla is in the contender category and has managed to develop AV technology that is close to level 5 autonomy. Currently they are testing cars have the ability to be "summoned" by the owner–allowing someone to start from where it's parked and go where he or she is located through an app on their phone. While this is very high level automation, Tesla cars on the market are still in the level 2 range.

Players outside of the car manufacturing industry are trying to find their place in this market as well. Uber recently launched a pilot test in Pittsburgh and moved to Arizona when registration for their 16 AV Volvos was revoked in the state of California. This is after the DMV caught wind of an unapproved pilot in San Francisco. Technology is moving fast and a number of companies are vying for a leadership position, which can put them at odds with the government. We recommend local government encourage dialogue and partnerships with companies conducting pilots to anticipate technological advances and plan for changes to policy, budget, and infrastructure.[10]

Current Partnerships

The direction of AV technology development means the greatest effects will be seen in cities, and not on highways.[11] Developing public private partnerships (PPP) is a way for cities to have an active hand in shaping how AV technology affects urban areas and public transportation. The right partnerships will focus on meeting the goals of each city for improving transportation, livability, and budgetary constraints.

Figure 3



Cities are starting to develop PPPs with existing AV players. Partnerships with Uber and Lyft are used to provide increased access to public transportation from less dense urban areas. The New York Public Transit Association summarized multiple city partnership with Lyft that includes suburban service, first and last mile, paratransit, commuter train access services, and parking congestion mitigation. Most of these services provide subsidized or free rides to connect to the larger public transportation system, or to minimize private vehicle commutes within the city. Some cities are testing AV shuttles to help underserved areas access the public transportation system.[12]

The University of Michigan AV research and testing facilities works in partnership with 65 industry members, including Ford and Toyota, the Michigan Department of Transportation, the

9 Abuelsamid, Sam. 2017. "To Make A Truly Autonomous Car, GM Is Making Some Big Changes Under The Bolt's Hood." Forbes. September. Accessed November 30, 2017. https://www.forbes.com/sites/samabuelsamid/2017/09/11/gm-and-cruise-automation-debut-3rd-gen-automated-bolt-designed-for-production/2/.

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12 New York Public Transit Association, Inc. 2017. Lyft Partners With Transit Agencies Around the Country. Accessed November 11, 2017. https://nytransit.org/lyft-partners.

American Center for Mobility (a nonprofit) and multiple UM professors. Projects include a closed facility to test AVs in a replicated urban environment, testing of connected vehicles on public roads in Ann Arbor and SE Michigan, and research funding around AV and connected vehicles.[13]

Adoption Scenarios

Although we have some advancement in terms of AV testing and acceptance among the general population, predicting adoption rates and evolution of the technology is next to impossible. And without an idea of how this will play out, it's difficult to anticipate needs and roadblocks that would guide policy and urban development. For this reason, exploring scenarios of adoption and the implications of each is a productive next step.[14]

Scenario 1 (worst case) - Individually Owned Autonomous Vehicles

In this scenario, most people replace a car with an autonomous vehicle. There are efficiencies in terms of electrification and improved traffic flow that provide environmental benefits. And the removal of human error would make roads safer. However, the opportunity for reducing cars on the road that would lower congestion and demand for parking is lost. People may decide to live farther away and urban sprawl would increase. Given that car ownership is the norm, more than half of people surveyed about AVs (59%) said they'd be more interested in owning an AV than using services like Uber or Lyft to get around.[15] The draw toward personal ownership relates to freedom and misconception of wait times and expense. Many aren't taking into account the difference between fixed and variable costs related to owning versus sharing. However, according to RethinkX, "Transportation as a Service (TaaS) would be four to ten times cheaper than buying a new car and two to four times cheaper than operating an existing vehicle in 2021."[16]

Scenario 2 (best case) - Only Shared Ownership Model of AVs

In an ideal world, individual ownership of AVs would be incredibly rare. Adoption of ride-sourcing or ride-sharing services (TaaS) would be widespread. Not only that, ridership of public transit would go up due to the increased access to those services through AV ride-sourcing technology.[17] This would result in increased utilization of vehicles and thus decrease trips per day per car. It has enormous positive implications for the environment and quality of life through reducing congestion.[18] Also, due to increased demand of ride-sourcing, supply would go up and price would decrease. Those far away from city centers and unable to pay for these services before could access this technology and use it for the last mile of their trips. With this evolution in mobility, new development in cities would cater to ride-sharing and sourcing models by forgoing parking and improving infrastructure for public transit and shared rides.[19] However, to get to this ideal scenario, public and private sectors will need to work together to prioritize and incentivize shared-used AVs and public transit. Attitudes toward car ownership must dramatically shift to associate AV technology with public transit rather than individual mobility.

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13 Whitehouse, Brad. 2017. Ann Arbor: A hub for autonomous vehicles. 15 October. Accessed November 11, 2017. https://news.engin.umich.edu/2017/10/ann-arbor-a-hub-for-autonomous-vehicles/.
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Scenario 3 (middle case) - Mixture of Privately Owned and Shared Ownership Models

Banishing individual ownership of AVs is unlikely at the start. Changing behavior and attitudes will take some time and with the technology in flux, it's difficult to anticipate needs well enough to enact policy or incentivizes that lead to scenario 2. In all likelihood, the evolution from private ownership to a shared-used model would be gradual. Some people would individually own early AV models while government and companies are implementing systems to incentivize shared-used models. However, actions taken now by private and public entities would determine how quickly this evolution would take effect.

Case Studies

City budgets and taxes

Given the disruptive power of AV technology, we recommend governments consider the impact it can have on governments' existing budgets and tax schemes. Revenue sources for city budgets vary widely by source and amount, but generally encompass property taxes, business taxes, as well as sales and use fees. The evolving urban landscape will impact property values and business taxes. For example, federal and local governments will see less revenue from fuel taxes every year due to AV's association electrification.[20] AVs will require significantly less parking leading to less municipal parking fees and perhaps, more space for local business to flourish. Governments should consider changing the way they approach budgets and find ways to compensate for lost revenue in an evolving landscape shaped by AV technology.

Per-mile tax on AVs

Legislators and other officials in Tennessee and Massachusetts have suggested a per mile tax on self-driving cars. In Massachusetts a tax of 2.5 cents per mile has been proposed and in Tennessee legislators agreed on a 2.6 cent per mile tax on self-driving trucks with more than two axles and a one cent per mile tax on self-driving cars. Unfortunately, this topic is still being heavily debated. Some claim imposing a tax will discourage AV technology adoption while others argue it is necessary for mandatory infrastructure changes to account for widespread AV adoption. Regardless, this is a huge opportunity. According to the DMV, if the taxation of AVs is implemented, it could generate up to $300 million per year for federal, state, and local governments.[21]

Currently Oregon has enacted legislation that created the program called OReGO. This program uses voluntary participants to test a pay-per-mile tax system charging 1.5 cents currently, but increasing to 1.7 cents as of January 1, 2018. This program is overseen by the Road User Task Force, a committee of state legislators, local government officials, citizens and other professionals. They were tasked with studying and developing new ways to produce funds for the roads and bridges in Oregon. Pending successful results, this could go into effect resulting in potentially increased cost in operating city busses as they are not exempt from paying the gas tax. If this program is adopted and enforced for all vehicles, as is planned, TriMet will not be exempt from this under the current policy structure.[22]

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20 Clark, Benjamin Y., Larco, Nico, Mann, Roberta F. 2017. "The Impacts of Autonomous Vehicles and E-Commerce on Local Government Budgeting and Finance." Ubanism Next, Sustainable Cities Initiative (University of Oregon).
21 2017. "Autonomous Vehicle Taxes May Arrive Before the Cars Do." 12 September. Accessed December 1, 2017. https://www.dmv.org/articles/self-driving-car-taxes.
22 MyOReGO. Accessed December 1, 2017. http://www.myorego.org/about/.

AV testing in Nevada

Oregon currently has no legislation in place regarding AVs. This will most likely change due to Mayor Ted Wheeler declaring Portland "open for business" for autonomous vehicles.[23] Examining other states' approach to this process is advised in order to have a successful program that welcomes safe testing of AV technology. For example, Nevada adopted an application process for manufacturers, software developers and other parties to obtain a permit to test AVs in the state. According to the Nevada AV Business License Application, this application process requires a $101 one-time fee, and if approved, additional plate fees of $21 per vehicle that must be displayed at all times. The testing permit expires after 1 full year at which time the fees must be paid again. Fees along these lines have been enacted in several other areas and have become the norm just as license and plate renewal fees for vehicles exist today.[24]

Incentivizing Shared-Use Vehicles

Congestion tax and electronic road pricing

Hitting people in their wallets is one strategy to discouraging driving privately owned vehicles, which will be crucial to ensure that AV adoption is associated with shared-use and multi-modal transit. It also brings in additional revenue to account for changes in tax schemes and city budgets. Take, for example, London's congestion tax. In 2003, London implemented a tax in the city center charging vehicles that weren't shared use £11.50 from 7 a.m. to 6 p.m. This has tremendous positive implications. Congestion went down by 26%. Greenhouse gas emissions were reduced by 16% in one year. Passengers entering the congestion zone by bus increased by 37%. They made £122 million in net revenue in 2005 and 2006 and accidents were reduced by 40-70% within the congestion zone.[25] Singapore was one of the first to charge residents a tax in 1975 and in 1998, they switched to an Electronic Road Pricing system that charged people according to type of vehicle, routes, and time of day. This reduced congestion in restricted areas by 16%.[26]

In both of these cases, the cities spent years planning and implementing the new systems. They made sure alternative forms of transportation were abundant and accessible. They also invested in education around the new system and ways to avoid the tax. Of course, implementing initiatives like these in US cities would be difficult from a political standpoint– resistance would be inevitable from those that live farther away and depend on the car as a cheap way to get into the city. Both cases had the government on their side–Singapore's centralized government makes it easier for policies to go into effect. And the politician spearheading the London project, Ken Livingstone, was elected with this being a major aspect of his platform. This may be more difficult for cities in the U.S. when single-occupancy and privately owned vehicles are so widespread.

Parking Reduction

According to a report by McKinsey and Company, each parking space that can be saved on a corporate campus is equivalent to about $10,000-$20,000.[27] And it's suspected that with AVs we will need up to 90% less parking.[28] We recommend that cities start limiting or eliminating

23 Njus, Elliot. 2017. "Mayor wants to bring self-driving vehicles to Portland." OregonLive.com. 19 April. Accessed December 1, 2017. http://www.oregonlive.com/commuting/index.ssf/2017/04/mayor_wants_to_bring_self-driv.html.
24 Nevada Department of Motor Vehicles. 2017. July. http://www.dmvnv.com/pdfforms/obl326.pdf.
25 Centre for Public Impact. n.d. "London's Congestion Charge." Accessed November 15, 2017. https://www.centreforpublicimpact.org/case-study/demand-management-for-roads-in-london/ .
26 Institute for Transportation and Development Policy. n.d. "The Case for Electronic Road Pricing." Development Asia. Accessed October 30, 2017. http://development.asia/case-study/case-electronic-road-pricing.
27 Bouton, S. Knupfer, S. Mihov, I. Swartz, S. 2016. "Urban Mobility at a Tipping Point." McKinsey & Company.
28 Clark et al, "The Impacts of Autonomous Vehicles and E-Commerce on Local Government Budgeting and Finance.", 2017.

new parking for new construction to encourage alternative forms of transportation and the shared use of vehicles, especially with the onset of autonomous technology. This saves developers money and opens up room for business that can further stimulate the economy.

Many cities have parking minimums to ensure each occupant has a parking space allocated to them. This summer, Santa Monica got rid of parking minimums to make development cheaper and alternative forms of transportation more attractive. One developer in San Francisco offered tenants $100 toward ride-sharing apps to reduce the need for expensive on-site parking.[29] Zurich went a step further in 1996 by declaring there was a cap on new parking spaces. If anyone wanted to build new parking, they would have to find a way to eliminate the same amount of spaces elsewhere in the city.[30]

Why does parking matter when discussing AVs? Anything that can be done to limit individual vehicle ownership increases the likelihood of this technology being accepted as shared-use technology. Companies react to the market. If the market is conditioned to using shared AV technology, whether that be public transit like shuttles or ride-sourcing applications, the private sector will develop solutions to meet those needs.

Public Private partnerships

The rapid advances in AV technology, as well as the rapid uptake of TNC usage is creating new challenges and opportunities for municipalities and transit districts. An essay by McKinsey & Company has identified three PPP models that cities are developing to improve public transit, including collaborations with TNCs. The models include technology integration through third-party technology to allow access to information and ticketing in one simple location that allows trip planning across modes, i.e., fleets of small AVs that could be hailed via an app using third party technology or vehicles and subsidizing rides via TNCs to allow passengers to access transit hubs.[31]

Innovations and pilot studies around these three models are in development today. Los Angeles County Metro (Metro) recently released an RFP for the development of a MicroTransit system. They are seeking PPP to plan, design, and implement a service to encourage multi-model transportation by creating complete trips. The plan calls for smaller vehicles that can be hailed using an app within defined zones to connect more people with the Metro transportation system. Fare costs aim to be somewhere between traditional bus fare and a TNC fare, with discounts for transfers to the primary public transit system. The overall goal is to decrease commutes by car by creating better access to public transportation for more people.[32]

TriMet's own Open Trip Planner Shared-Use Mobility (OTP SUM) system funded by a MOD Sandbox grant, is another example of using PPPs to harness new technologies to meet transportation goals. The plan is to create a user-friendly system that allows people to easily plan, pay for, and access their trips through integration of bike-share, TNCs, and public transit. Open-source data and software will help create more reliable location services and web or mobile based access. TriMet will integrate pedestrian infrastructure data, and their Equity and Accessibility Plan into the system. As part of the grant, the entire project process and tracking is available online, and the models developed will be shared with other transit districts.[33]

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29 Hand, "Redefining Urban Mobility: Four Ways Shared Autonomous Vehicles Will Reshape Our Cities," 29-52

30 2012. "Lessons from Zurich's Parking Revolution." City Lab. Accessed November 5, 2017. https://www.citylab.com/transportation/2012/08/lessons-zurichs-parking-revolution/2874/.

31 Bouton, S., Canales, D., Trimble, E. 2017. "Public-private collaborations for transforming urban mobility." McKinsey&Company. November. Accessed November 11, 2017. https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/public-private-collaborations-for-transforming-urban-mobility.

32 L.A. Metro. n.d. "Micro Transit Pilot Project." Accessed November 11, 2017. https://www.metro.net/projects/microtransit/.

33 TriMet. n.d. "MOD Sandbox." Accessed November 11, 2017. https://TriMet.org/mod/.

Recommendations

Once testing is complete, work on developing budget and implementing a new tax scheme focused on making public transit work

We recommend that TriMet consider and budget for potential taxes related to the implementation and use of AVs. This includes policies like the per-mile tax in Massachusetts and Tennessee, which suggests a system based on every mile traveled by an AV whether or not it is used privately or publicly. As it is not yet enacted, we are not suggesting an aggressive approach to influence policy. Rather, we recommend conducting an analysis of the potential effects a tax like this would have on the organization financially. For example, city staff may choose to include a line item in the budget for AV programs or systems TriMet is exploring. According to the DMV's website, legislatures believe it is likely this tax scheme will go into effect. Therefore, preparation is key to ensure TriMet is financially prepared to incur these liabilities when the taxes were enacted.

As previously mentioned, Oregon's Department of Transportation is already testing a pay-per-mile driving fee that will apply to all cars. Although this tax isn't in direct response to AVs, but electrification, the two technologies will go hand in hand in the future. It is crucial that this tax scheme is designed to encourage multi-modal transit, but there are fears it makes existing bus travel more expensive. Currently, the test rewards fuel efficiency of 20 mpg or above. According to Duluth Transportation Authority, the typical hybrid city bus gets 5.6 mpg and 4 mpg, respectively.[34] This could mean serious cost increases for companies like TriMet. TriMet should consider advocating for public transit in response to a potential per-mile-tax system. According to the US Department of Transportation, the average transit bus travels 34,053 miles per year. At a rate of 1.5 cents per mile that would be approximately $51,080 of tax that will be paid per bus. This is a huge increase and has the potential to increase costs to public transit users potentially decreasing the amount of use. To combat these potential problems, TriMet could volunteer to add public transit to these tests runs of pay-per-mile tax. This would introduce the problems a pay-per-mile system may have in the public transport sector earlier on in the process while encouraging a system rewarding multi-modal riders with cheaper transit options.

Influence policy that makes shared-used AVs and multi-modal transit more convenient, cheaper, and faster.

According to a McKinsey study, the United States has the highest car ownership rate in the world–1.93 cars per household.[35] This started with the advent of the car in the 1950s leading to people moving out of cities and into big houses in the suburbs. With the advent of autonomous technology, there is enormous opportunity to reduce congestion and stimulate the local economy through policies that discourage single occupancy vehicles.

Implementing a congestion tax would be an excellent way to condition the public for shared-used AVs and multi-modal transit. This would place a premium on driving into crowded areas at high traffic times in a single-occupancy vehicle. Public transportation and shared-used vehicles would be exempt from the fee making it much more economically viable to choose that type of transit. Prior to implementing this tax, it is crucial that alternative forms of transportation are available for those living outside of the city and that it is easy to plan trips using multiple types of transit. As previously mentioned, TriMet's Open Trip Planner makes it easier for residents to make informed mobility decisions.[36] This would be a tool for making policies like a congestion tax viable.

34 *Duluth Transit. n.d. "Hybrid Buses." Accessed December 1, 2017. http://www.duluthtransit.com/green/hybrid.*
35 *Bouton et al, "Urban Mobility at a Tipping Point," 2016*
36 *TriMet, " MOD Sandbox," 2017*

Limiting or removing parking has an enormous impact on people's' willingness to drive and it's a relatively low hanging fruit that TriMet can work with policy makers on. Policies like Zurich's that puts a cap on parking spaces for new construction could be considered. To compensate, citizens must have alternate forms of transportation that could come in the form of AV shuttles, ride-sharing, and public transit. Since the requirement for parking is removed, building owners can use that money toward making access to these transit options easier–offering stipends for shared-used AVs or public transit, clearing an area for shared-used vehicle drop-off zones, and redesigning the building so the entrance discourages private vehicles.37 This also frees up land for businesses to set up shop, increasing property taxes the government can use to compensate for lost revenue from parking meters and the gas tax.[38]

Engage private sector early and establish trusted partnerships

Local governments and transit agencies can help create more accessible and less congested cities by being proactive around AV laws. TriMet is an integral part of making Portland and the surrounding communities livable and accessible by providing safe, dependable transportation services.[39] But AVs are coming to market and the right partnerships could enhance existing transportation services. Partnering with the companies developing AVs and connected technology will allow TriMet options to use the technology to help meet the City of Portland's SAVI directives.

Partnerships can be as simple as a city working with a TNC to provide subsidized first-last mile rides. Specific drop-off locations that ensure access to the larger public transportation system would increase access from less dense, or under-served areas of the city. Similar partnerships provide free rides into the city center during highly congested times, or special events to avoid parking congestion issues.

Beyond subsidized rides, transit agencies should look to partner with private companies developing the technology for AVs, apps and software, or data collection and analysis. Micro-transit AV shuttles can be explored to enhance existing transportation options and provide complete trips.[40] Integrating trip planning and payment systems encourage multi-modal transportation options. The success of this type of technology partnership could help cities reach the best-case scenario where ride-sharing services and public transit work together, making shared transit available throughout the city.

37 *Hand, A. "Redefining Urban Mobility: Four Ways Shared Autonomous Vehicles Will Reshape Our Cities," 29-52*
38 *Clark et al, "The Impacts of Autonomous Vehicles and E-Commerce on Local Government Budgeting and Finance.", 2017*
39 *TriMet. n.d. Accessed November 11, 2017. https://TriMet.org/about/organization.htm.*
40 *Descant, S. October 27 2017. "LA County Metro Investigates Micro-Transit Possibilities". Accessed December 12 2017.* http://www.govtech.com/fs/transportation/LA-County-Metro-Investigates-Micro-Transit-Possibilities.html

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Bike-share Expansion Feasibility Framework

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Executive Summary

Bike-share is rapidly expanding in major cities around the world as a favorable transportation mode among locals, tourists, and people looking for a leisure activity. Portland has joined the ranks of top bike-share programs in the United States with their 100 stations representing the ninth largest deployment among the 113 U.S. cities with a program.[1] With the initial launch successful, Portland must now move towards expansion of the Biketown program in the city. Looking to industry best practices, successes in Montreal and New York City, and the failure in Seattle, our team identified key variables that need to be considered if Biketown is to expand successfully. These findings include accessible, safe bike lanes designed with bike stations; a station density target of 28 stations per square mile; station spacing of approximately 1,000 ft apart; outward expansion executed strategically using Geographic Information Systems (GIS) data; connecting communities to other modes of public transit (especially in low income areas); reliable funding including public commitment if private funding lacks, partners vested in the city; and effective marketing to the target demographics (people 24-35 years of age). Portland has the people, knowledge, and commitment to execute an expansion that makes bike-sharing a part of the urban fiber of the city.

Portland Bike-Share Overview

In July 2016, Portland launched its first bike-share program, Biketown, with investment backing from Nike. One hundred docking stations were deployed in the downtown area to support 1,000 bright orange Nike Biketown bicycles. The program launch has been considered a success, supported by the statistics[2] shown below and by gaining additional sponsorship through Kaiser Permanente.

- Active Annual Members: 3,519
- Casual Members (day pass, single ride, or other short-term plans): 72,002
- Average trips per bike per day since launch: 0.95
- Average trips per bike per day since July 1, 2017: 1.85
- Total miles ridden: 602,266
- Total trips taken: 313,034
- Average distance/trip: 1.92 miles

Sixteen months after the initial Biketown launch, the program has modestly expanded docking stations to the north, northeast, and southeast, installed two Super Hub Zone pilots at Portland State University and Central Eastside Industrial District, and added a satellite pilot at Swan Island. Additionally, on July 21, 2017, the city launched a pilot for Adaptive Biketown that consists of ten bike rentals designed for those with disabilities to make the bike-share system inclusive to all residents. Portland is now looking to expand on the initial success of the Biketown program, but needs to decide on the path best suited for successful, sustainable growth.

Best Practices

The National Association for City Transportation Officials (NACTO) is currently a leading institution in disseminating information about city bike-share systems. There are five key tenants to bike-share station locations.[3]

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1 Malouff, Daniel. (January 26, 2017). All 119 US bikeshare systems, ranked by size. Greater Greater Washington. https://ggwash.org/view/62137/all-119-us-bikeshare-systems-ranked-by-size. Retrieved November 17, 2017.
2 (July 17, 2017). Biketown celebrates first birthday with a week of prizes, Free Ride Day on Wednesday July 19, 2017. PBOT. https://www.portlandoregon.gov/transportation/article/647336. Retrieved November 9, 2017.
3 NACTO. Bike-share Station Guide. https://nacto.org/wp-content/uploads/2016/04/NACTO-Bike-Share-Siting-Guide_FI-

Accessible and Convenient

Accessibility and convenience are the most important factors to keep in mind when siting bike locations. It is common to place bike-share locations in high-traffic areas, but it is also important to place stations in low income neighborhoods as this is the fastest growing cycling population. While pedestrians will walk up to a ½ mile to use a commuter rail, the average bike-share user will not walk more than ¼ mile (five minutes) to access a bike-share station. In a NACTO survey, 59% of people choose bike-share because it is convenient. In order to make trips convenient, bike-share stations need to create a close network near locations that people make trips to. Bike-share locations in close proximity to other stations receive exponentially more riders. The optimal station density is 28 stations per square mile with stations about 1,000 feet apart.[4] See Figure 1 in the Appendix.

Many cities choose lower density over a larger service area, however, this reduces service quality and makes bike-share less convenient. In order to increase density, it is recommended to implement smaller stations in more locations. NACTO has a GIS system that can help cities determine the proper placement for bike stations, a great resource for Portland's Biketown.

Safety

Station placement can become part of road safety redesigns. On-street bike-share stations can protect bike lanes, help define the pedestrian space, and increase pedestrian visibility (See Figure 2 in the Appendix). Many bike-share riders are also new riders. Placement near protected bike lanes helps to ensure safety and comfort of this group. Low income individuals suffer disproportionate risks of casualties and injuries caused by bad drivers and poor road designs. Strategic placement in low-income neighborhoods can increase safety and also improve equity.

Transit Expansion

More than 50% of bike-share users link bike-share with other public transportation options. Stations by public transportation helps commuters travel the distance between their public transportation stop and passenger destination.

Economic Activity

Proper bike-share locations can help to bring new life to a city. A New York survey found that bike-share stations that replace metered parking increase total commercial spending by 52%. One parking spot can accommodate about 10 bikes, and pedestrians tend to spend more money at local businesses than drivers.

Bike-share placement in parks offers a unique set of opportunities and challenges. Parks can be excellent locations to provide access to public space, but there is the challenge of safety at night. An analysis of the park in question is important to determine the feasibility. Placement at park edges allows access to both park and street riders.

Case Studies

Montreal - Successful

In Montreal, Quebec the BIXI bike-share system is thriving. The nonprofit has been operational in the French-Canadian city since 2014 and currently has 6,200 bikes and 540 stations on the road. BIXI's success has been a model for many North American cities as they look to implement bike-share programs. Not necessarily known as the most bike friendly topography,

NAL.pdf

4 NACTO. Walkable Station Spacing is Key for Bike-share https://nacto.org/wp-content/uploads/2015/09/NACTO_Walkable-Station-Spacing-Is-Key-For-Bike-Share_Sc.pdf

there are numerous factors that have played into BIXI's success in Montreal including grassroots demand, bike friendly city planning upgrades, transit interconnectivity, consumer convenience, a defined target markets, and strategic partnerships.[5]

Montreal is home to some of the most active and outspoken bike enthusiasts dating back to the 1970s. There were several different cyclist societies who would frequently campaign and protest against the lack of bike-friendly infrastructure. Two different bike enthusiast societies made specific strides in integrating people that bike into Montreal's transit system and in 1985 with the construction of the city's first bike lane, the Tour de L'Île initiative was launched. Tour de L'Île is a yearly mass ride through the city of Montreal that has two objectives: encourage the city to bike more often, and send a political message that with 30,000 participants cycling integration needs to be on the forefront of their policies. A passionate cyclist counter culture may not be native to many cities, but this presents a key insight that if demand and backing can be generated on a grassroots level, then it is very likely that policy will follow suit [6]

Convenience has been key to the success of BIXI. In constant efforts to adapt city planning, Montreal has established 400 miles of bike lanes. What's even more impressive is that 150 miles of these cyclist only lanes are completely separate from motor transportation. This improves safety and likely recruits a few more riders to the system. As well, in the winter months the city clears 150 miles of the path from snow in order to encourage safe winter riding.

An added element of convenience, BIXI has been integrated into the Montreal public transit system from the inception of the bike-share platform. Riders can use multiple forms of payment including an Opus transit card. One technology improvement that BIXI is looking to offer in the future is a transit pass that can be scanned at docking stations via smartphone. Convenience and interconnectivity are key contributing factors that have led to more than 4.8 million BIXI rides in Montreal in 2017.[7]

In 2018, BIXI will undergo another upgrade in Montreal. The objective this time is to increase efficiency and expand services. They plan to install new docking stations that have the capacity for twice the amount of bikes as the current station. This means that a full station will have 80 bikes in total. There is such high demand for BIXI's, especially on the morning work commute, so more expansive docking stations will equate to less time spent bikeless and less stranded commuters. Docking stations run on solar power and are modular meaning that they can be moved and relocated in a matter of minutes. There is the potential that Montreal will see dockless stations in the near future as BIXI begins to discuss and test GPS capabilities.

One final consideration in studying the BIXI Montreal system is the strength in marketing efforts and strategic partnerships. Very early on, BIXI identified individuals between 25 and 34 that have average income around $35,000.[8] In narrowing their focus, BIXI was able to craft a strategic marketing plan that spoke to these individuals. In addition, BIXI sought strategic partnerships that would help bring legitimacy and brand awareness to the nonprofit. For example, BIXI partnered with local bike shops around the city to provide discounts on helmets to BIXI members. The feature sponsor of BIXI today is Canadian insurance powerhouse Manulife.[9] Together they developed the Free BIXI Sundays promotion, which draws in first time users and current members alike. Additionally, BIXI has partnered with transit solutions such as Opus, Car2Go, CAA and Communauto in order to offer bundled packages to drive costs down and promote the connectedness of transit solutions.

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5 Collier, R. (2017, September 1). Bixi to roll out new docking stations in 2018. Retrieved from Montreal Gazette: http://montrealgazette.com/news/local-news/bixi-to-roll-out-new-docking-stations-in-2018

6 Walker, P. (2015, June 17). People power: the secret to Montreal's success as a bike-friendly city. Retrieved from the guardian: https://www.theguardian.com/cities/2015/jun/17/people-power-montreal-north-america-cycle-city

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New York City - Successful

With four years of operation, Citi Bike in New York City is considered the nation's greatest bike-share success story. In 2016, New York City riders took Citi Bike for over 14 million trips, accounting for half of all rideshare trips in the United States. There are currently 10,000 bikes deployed in the city with plans to expand by 20%, or an additional 2,000 bicycles, by the end of 2017.[10] High urban population density is a notable factor to the bike-share programs' success. Beyond this non-replicable (or desired) population density, three other factors also had a critical contribution to Citi Bike's success that Portland should consider with its own bikeshare expansion: infrastructure, station density, and connections.

Infrastructure

New York City has executed on its commitment to build an infrastructure that supports bicycle use. New, protected bike lanes have made cycling commutes more accessible and safer, and therefore more appealing to riders. The city also integrated Citi Bike stations into the bike lane design. The high level of convenience, to grab a bike and already be on the bike lane, makes biking a desirable, low cost, and often faster transportation option. The infrastructure investment has resulted in bicycles becoming a part of the urban mobility system.[11]

Station Density

From Jay Walder, CEO of Motivate, the company that operates Citi Bike, "one of the things that people say to me is, 'It feels like Citi Bike is on every corner.' I think that's a fundamental aspect in terms of having successful bike-share. It takes away the sense of thinking about where a station is, and you just think about place, and you assume that a station will be nearby." Figure 4 in the Appendix , a snapshot of the lower part of Manhattan on the Citi Bike stations map,[12] illustrates how dense the Citi Bikes have been deployed throughout the city. Riders do not have to worry if there is an available bike when they need it, they can begin their commute confident that a bike is closeby to get them to their destination.

Connections

The busiest docking stations are those connected to other modes of public mass transit such as subways, buses and ferries[13]. By integrating bike-share with these other modes of transportation, the system expands beyond a niche transportation option, a tourist allure, or a leisure activity and becomes a part of the transportation system that locals use and depend on. Gaining local acceptance continues to drive Citi Bike's success.

Seattle - Unsuccessful

Seattle's Pronto! program serves as an example of one of the most notable bike-share programs that was unable to become successful. The program lasted just over two years, from October 2014 to March 2017. There is not widespread agreement on why the program failed, but most argue it is some mixture of poor funding, low ridership, lack of effective launch and expansion, and political issues.[14]

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10 (2017). Bike-share in the US: 2010 - 2016. National Association of City Transportation Officials. https://nacto.org/bike-share-statistics-2016/. Retrieved November 10, 2017.
11 Hobson, Jeremy & Walder, Jay. (May 27, 2017). 4 Years In, How Bike Sharing Has Impacted New York. WBUR. http://www.wbur.org/hereandnow/2017/05/26/citi-bike-new-york. Retrieved November 7, 2017.
12 (2017). Station Map. Citibike. https://member.citibikenyc.com/map/. Retrieved November 10, 2017.
13 Gordon-Koven, Lily. Why is Citibike so Successful? NYU Wagner Rudin Center for Transportation Policy & Management. https://wagner.nyu.edu/rudincenter/2014/02/why-citi-bike-so-successful. Retrieved November 10, 2017.
14 Small, Andrew. The Four Horsemen of the Bike-share Apocalypse, CityLab, January 2017, https://www.citylab.com/transportation/2017/01/seattle-bike-share-pronto-goes-under/513575/, accessed November 2017.

Poor funding

Most cities with bike-share programs have corporate sponsors, such as Citi Bank for New York City or Nike for Portland's Biketown. Pronto! financial projections, however, were heavily dependent on a future unnamed sponsor for a quarter of revenues. While Alaska Airlines initially committed $2.5 million, that was not enough to sustain the program and Puget Sound Bike-share—the nonprofit responsible for coordinating Seattle's program—was unable to secure additional sponsors. Puget Sound Bike-share eventually went under and the program was purchased by the City of Seattle.

Low ridership

There is not widespread consensus on why ridership numbers were so low. A few reasons are frequently discussed:

Seattle has notoriously rainy weather and a hilly topography that makes biking an unattractive option for many. On the other hand, bike-shares in other cities with similar weather and/or topography, like GoBike in San Francisco, have found success regardless of these issues.

Among the most densely populated cities, Seattle has the most cars per capita.[15] The car-centric culture and sheer number of vehicles on the road scares many casual riders away.

Seattle was the only city in the country with a bike-share program and a law requiring cyclists to wear helmets. This meant riders either had to bring their own helmets or rent a helmet from Pronto! for $2. This damaged much of the convenience and spontaneity associated with renting the bikes.

Lack of effective launch and expansion

If weather did indeed play a part in Seattle's failure, it is notable that Pronto! was launched in October, right as the rainy season starts in Seattle. This could have prevented the program from gaining momentum at a key time. Pronto! had initially planned to start with only 500 bikes at 50 stations in the downtown corridor and expand from there. However, station density was approximately 12 stations per square mile, even though experts recommend twice that.[16]

Politics

Lastly, there was no broad political consensus on bike-share. From the beginning, there were disagreements on infrastructure, the Puget Sound Bike-share buyout, and lack of champions on city council.17 It was commonly viewed as a fun program for Seattle residents and tourists, not a solution to major transportation woes.

Expansion Opportunities

Increase Density in Current Zone

Best bike-share location practices place docks 1,000 ft apart with an average density of 28 stations per square mile. Current station densities and analysis of the service area are as follows:

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15 Balk, Gene. Booming Seattle is adding cars just as fast as people, Seattle Times, August 2017, https://www.seattletimes.com/seattle-news/data/booming-seattle-is-adding-cars-just-as-fast-as-people/, accessed November 2017.

16 Cohen, Josh. Did Seattle's mandatory helmet law kill off its bike-share scheme?, The Guardian, April 2017, https://www.theguardian.com/cities/2017/apr/18/seattle-mandatory-helmet-law-kill-bike-share-scheme, accessed November 2017.

17 Small, Andrew. The Four Horsemen of the Bike-share Apocalypse, CityLab, January 2017, https://www.citylab.com/transportation/2017/01/seattle-bike-share-pronto-goes-under/513575/, accessed November 2017.

Northwest

The northwest downtown core reaches a station density of 20 stations per square mile. The service area west of the interstate drops in half to 10 stations per square mile. The northwest region is the most consistently dense quadrant.

Southwest

The southwest core near downtown reaches a station density of 25 stations per square mile. However, there are only four stations located outside of this inner core, dropping the average density for the area down to 10 stations per square mile. This area sees the highest density but also the largest variance within the service area.

Northeast

The most densely packed areas in the northeast reach 9 stations per square miles while other regions have zero. Commercial streets such as Mississippi and Alberta see stations spaced at the recommended 1,000 feet apart, but only along a single corridor. The Lloyd and Moda center area also reaches a higher density, but only in a very confined space. The northeast is the largest service area for Biketown.

Southeast

The southeast sees fairly uniform placement of stations at a density of about eight stations per square mile. Stations are primarily placed along major throughways in this quadrant.

To achieve an increase in ridership, station density is recommended to increase to a target 28 stations per square mile, spaced approximately 1,000 ft apart, within each service area. Expansion to reach this target should be executed strategically. The best method to determine ideal new locations would be utilizing GIS with overlays of current service density; economic activity; current transportation options; and population by density, age, and income. However, a low hanging fruit may be to focus on increasing density in the west neighborhoods, particularly in the University District where there is an active pedestrian population. Utilizing more, small stations over large sparse stations is a low cost option to hit station density targets.

Furthermore, few stations are located near residential areas, meaning bike-share is not being offered as a last mile solution. Increasing density in an eastern neighborhood that commutes to the station-dense downtown for work may be a great pilot study on the benefits of increased station density. Biketown may also look into a promotion month allowing users no additional fee to park bikes outside of a docked location. By studying bike parking locations during this promotion, Biketown will be able to see where riders are telling the company they want to end up.

Expand to New Areas

The “Biketown Proposed Service Area and Station Changes” plan released in May 2017 includes one major and four modest expansion areas.[18] Using NACTO’s “Bike-share Siting Goals,” the areas suggested below have the following benefits and drawbacks.

North and Northeast Portland

The expansion into N/NE Killingsworth and NE Alberta St. allows Biketown to locate stations within the Alberta Arts District, a popular restaurant and shopping destination for both tourists and locals. Major businesses and attractions include Salt and Straw, Pine State Biscuits, Green Bean Books and Tumbleweed, in addition to a popular monthly art walk in the neighborhood. Due to the high foot traffic in this neighborhood, stations would be safe,

18 https://www.portlandoregon.gov/transportation/article/637769

convenient and accessible, as well as operationally feasible. For further convenient travel, there are neighborhood greenways (streets with low traffic volume and speed where bicycles, pedestrians and neighbors are given priority[19]) located two and four blocks south on NE Going St. and NE Skidmore St., respectively. As a result, this neighborhood would likely experience high volumes of bike-share traffic.

In addition to the Alberta Arts District, this area of expansion also includes the neighborhoods contained by NE Prescott and NE Tillamook Streets on the north and south and NE 7th and NE 21st Avenues on the west and east. Unlike the Alberta Arts District, however, this neighborhood is primarily residential and does not include many of the benefits listed above. It would also be difficult to incorporate stations into the larger streetscape hierarchy since there are single-family homes occupying the majority of these streets.

Swan Island Satellite

Although this expansion area is small in size, it includes the Daimler Trucks North America headquarters, which houses several hundred Daimler employees. Besides Daimler, this area also includes a handful of warehouses and wholesale businesses, as well as a few fast food restaurants. Although it would be easy to build into the streetscape hierarchy, this expansion may face obstacles because it is not designed for bicycle safety, it does not border areas currently served by Biketown, and it may not be operationally feasible to rebalance and maintain bicycles. However, it is worth noting that Adidas North America is approximately a mile away and Adidas, which is planning on expanding from 1,700 to 2,800 employees over the next three years20, could provide an opportunity for Biketown to expand its service area to serve employees from both Daimler and Adidas.

South East Belmont and Hawthorne

This expansion contains two commercial nodes: SE Belmont St. between SE 40th and SE 43rd Avenues, which includes popular businesses like Slappy Cakes, The People's Yoga and a food cart pod, and SE Hawthorne Blvd. between SE Cesar Estrada Chavez Blvd. and SE 44th Avenue, which includes a New Seasons Market, Corbett Fish House and Common Grounds Coffeehouse. Similar to the N/NE Portland expansion area, these neighborhoods would allow for stations that would be safe, convenient and accessible, and operationally feasible. In addition, SE Hawthorne is bisected by the SE 41st Avenue greenway, while the SE Harrison Street greenway is a few blocks south and the SE Taylor Street greenway runs four blocks north of SE Hawthorne and two blocks south of SE Belmont. As a result of this, as well as the neighboring areas already served, Biketown has the potential to gain vast ridership in these neighborhoods.

Brooklyn and Central Eastside Industrial District

The final area suggested in PBOT's plan is unique in that it contains very few businesses open to the public and is primarily made up of manufacturing and warehouse businesses. However, it does include access to Tilikum Crossing, a bridge serving public transit and pedestrian/bicycle traffic only. While stations in this area would be simple to build into the streetscape hierarchy and operationally feasible, they would lack the pedestrian traffic, safety, and accessibility and convenience recommended in NACTO's goals. As such, it is recommended that further research be conducted on usage patterns and statistics in this area.

19 Neighborhood Greenways. Portland Bureau of Transportation, www.portlandoregon.gov/transportation/50518.
20 Manning, Jeff. "Http://Www.oregonlive.com/Business/Index.ssf/2017/10/post_261.Html." Oregon Live, October 11, 2017, www.oregonlive.com/business/index.ssf/2017/10/post_261.html.

Marketing & Communications

For TriMet's bike-share expansion to be successful, marketing and communications must be a considered. Below are two proposed strategic marketing focuses for TriMet: Target demographic and strategic partnership. The overarching objectives of these tactics is to ensure visibility among the correct target audience, increase the amount of first time trials, and earn customers for life.

Target Demographic: Men and Women aged 20-39

Portland is home to approximately 640,000 individuals, 35% of whom are between the ages of 20 and 39.[21] Montreal's bike-share program has an average user age of 25-39, while the New York system's median age is 35.[22] This target segment is largely made up of white collar workers with a mean income of $37,000. They are active individuals and use public transportation frequently. As well, they are social beings and take advantage of everything that Portland has to offer including sporting events, craft breweries, and the endless food cart options.

Strategic Partnerships

TriMet's bike-share program currently has five partnerships. Two of the partners are with bike technology companies and the remaining three are the Portland Bureau of Transportation, Kaiser Permanente, and Nike. To gain visibility among Biketown's target demographic, TriMet should seek additional partnerships with popular brands throughout the city. Two proposed areas of focus are sports teams and coffee. For example, a partnership with the Portland Timbers and Portland Thorns would allow TriMet to tap into the avid soccer fan base and could also help eradicate some of the traffic and parking issues at Providence Park on game days. Assets that TriMet might want to consider are promotions through the Timbers and Thorns social media or a free one-time trial ride with a code that is given out at a game.

Similarly, a partnership with Stumptown or Dutch Bros coffee would increase visibility and brand awareness among individuals aged 20-39. Perhaps, a partnership could include $1 off a Dutch Bros coffee for individuals that ride up on a Biketown bike. Another promotion example could be one free coffee at Stumptown with membership signup.

Biketown currently partners with a variety of local companies for tiered group pricing as part of the employee benefits package. A third tier could be added onto the partnerships option to help fund expansion opportunities. By signing up for a tier 3 partnership, companies would be willing to fund the cost of installing a new Biketown location at their office in return for better group pricing rates for employees. This would help fund new locations in areas where residents are likely to bike as well as increase ridership. Either strategy will increase visibility for TriMet and will likely result in favorable brand perception from affective image transfer of some of Portland's most trusted brands.

Finally, based on Montreal's success, it would be advantageous for Biketown to partner with additional transportation services in Portland. For more on public transportation partnerships, please refer to our Team 3 colleagues' report on Transit and Shared Use Mobility. Additionally, Montreal has partnered with car share services such as car2go to offer bundled packages. Bixi and car2go offer a $15 discount on annual Bixi memberships for car2go members, or a free car2go membership with a $10 drive credit by using a Bixi discount code. Portland is host to a variety of car sharing options to pursue for a similar promotion including car2go, Reach Now, Getaround, and Turo. Approximately 24% of individuals that used car sharing in the United States in 2016

21 Portland, OR. (2016, December 31). Retrieved from Census Reporter: https://censusreporter.org/profiles/16000US4159000-portland-or/

22 Campbell, B. (2017, 6 1). Sharing riders: How bikesharing impacts bud ridership in New York City. Retrieved from The National Academies of Science Engineering Medicine: https://trid.trb.org/view.aspx?id=1467740

were between the ages of 21-34, and 18% were between the ages of 35-49[23]. This means that by partnering with a car sharing service, Biketown will create another meaningful touchpoint to activate their key target demographic.

Summary

In order for TriMet to successfully expand bikeshare services, the proposed framework in this report should be thoroughly evaluated. It is important to lean into the initial success of the program, while garnering additional grassroots support for a more cycle-friendly Portland. Specifically, we recommend beginning by increasing density over expanding to new locations, placing docking stations strategically near transit, residential, and lower-income areas, and utilizing corporate partnerships to increase visibility, boost frequency of new user-demos, and fund new docking stations.

23 Statista. (2017, 11 17).

Appendix

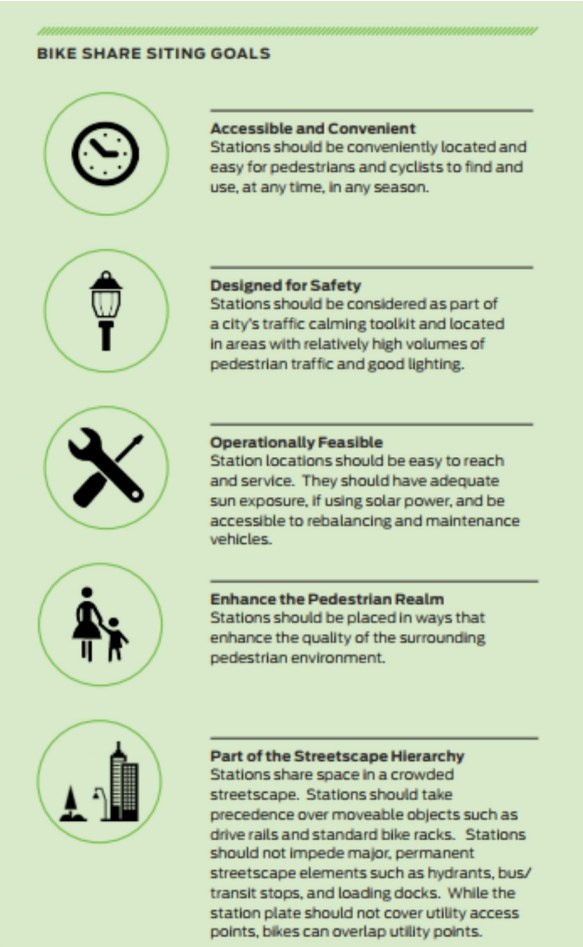

Figure 1: Key tenants to bike-share site location

Figure 2: Strategic bike placement to enhance bike safety in roadways.

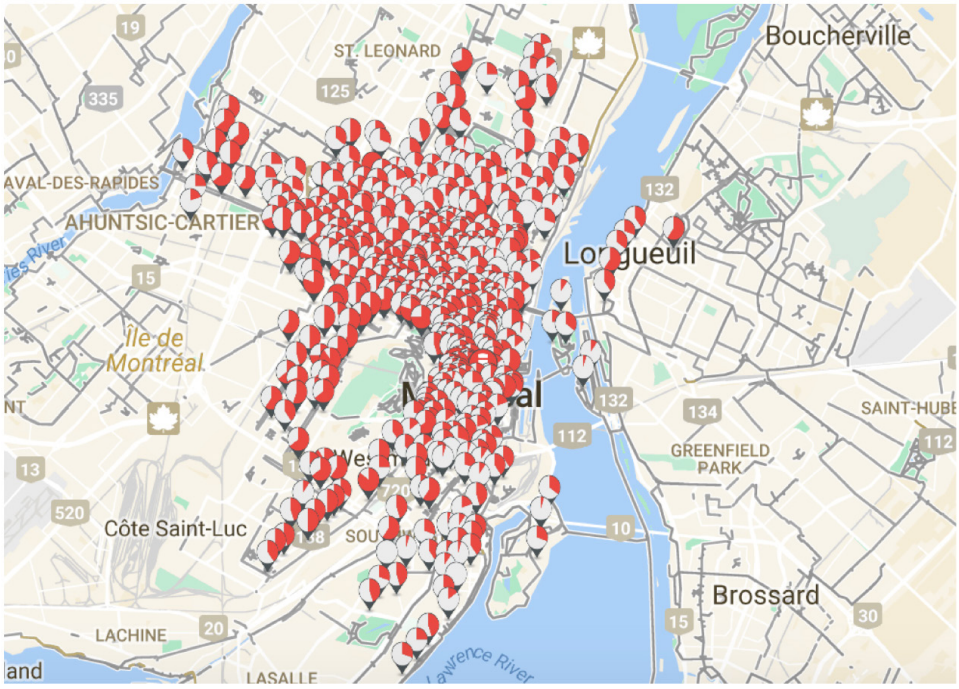

Figure 3: Snapshot of Bixi Bike stations in Montreal. Red dots describe how full each station is. https://secure.bixi.com/map/

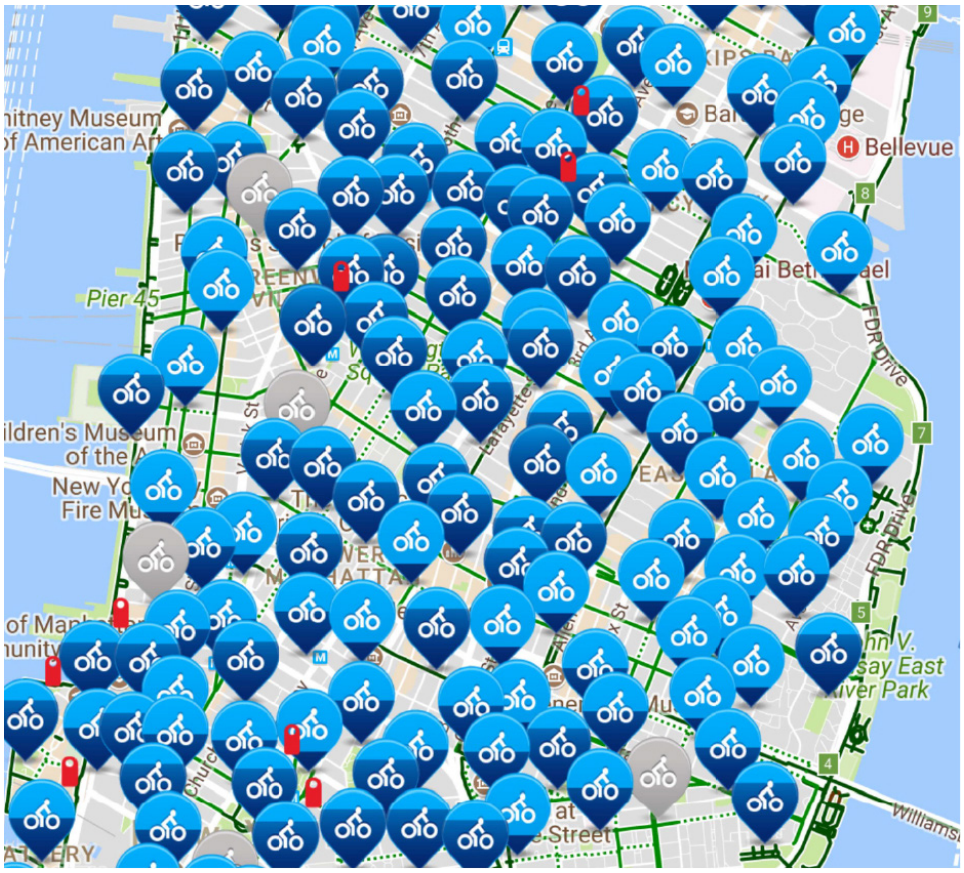

Figure 4: Snapshot of Citi Bike stations in lower Manhattan, New York City.