SHARED MOBILITY

A SUSTAINABILITY & TECHNOLOGIES WORKSHOP

Definitions, Industry Developments, and Early Understanding

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ABSTRACT

Shared mobility - the shared use of a vehicle, bicycle, or other mode - is an innovative transportation strategy that enables users to gain short-term access to transportation modes on an "as-needed" basis. The term *shared mobility* includes various forms of carsharing, bikesharing, ridesharing (carpooling and vanpooling), and on-demand ride services. It can also include alternative transit services, such as paratransit, shuttles, and private transit services, called microtransit, which can supplement fixed-route bus and rail services. With many new options for mobility emerging, so have the smartphone "apps" that aggregate these options and optimize routes for travelers. In addition to innovative travel modes, new ways of transporting and delivering goods have emerged. These "courier network services" have the potential to change the nature of the package and food delivery industry. Shared mobility has had a transformative impact on many global cities by enhancing transportation accessibility, while simultaneously reducing driving and personal vehicle ownership.

A number of environmental, social, and transportation-related benefits have been reported due to the use of various shared mobility modes. Several studies have documented the reduction of vehicle usage, ownership, and vehicle miles or kilometers traveled (VMT/VKT). More research is needed, nevertheless, to further understand impacts on a city and regional level and across the wide range of shared mobility modes.

Shared mobility could also extend the catchment area of public transit, potentially playing a pivotal role in bridging gaps in existing transportation networks and encouraging multi-modality by addressing the first-and-last mile issue related to public transit access. Furthermore, shared mobility could also provide economic benefits in the form of household cost savings, increased economic activity near public transit stations and multi-modal hubs, and increased access.

This white paper includes an introduction and background to different types of shared modes, as well as smartphone-based trip planning apps that can facilitate access to public transit and shared mobility services. This paper also notes where potential benefits of shared mobility could align with the new mission of the California Department of Transportation (Caltrans), which is to "*Provide a safe, sustainable, integrated, and efficient transportation system to enhance California's economy and livability*" (Caltrans, 2015a). We conclude the paper with a summary and provide an appendix with a glossary of terms and a list of the shared mobility models, including a range of companies in each sector.

INTRODUCTION

Traditionally in the United States, transportation options have emphasized personal vehicles and to a lesser extent other modes, such as public transit, bicycles, and taxis. Recent innovations in the sharing economy (a developing phenomenon around renting and borrowing goods and services rather than owning them) and information technology have expanded transportation and ownership models, spawning new businesses and changing how individuals plan and execute trips. Travelers can now hail a private driver and vehicle (e.g., Lyft and Uber); rent a car or bicycle for a short trip (e.g., Zipcar and Bay Area Bike Share); ride a shuttle on-demand (e.g., Bridj, Chariot, Via); and have groceries or takeout food delivered in someone's personal vehicle (e.g., Postmates and Sidecar Deliveries)—all using the Internet and smartphones. These innovative transportation services are expanding at a time when agencies, such as state Departments of Transportation (DOTs) and regional Metropolitan Planning Organizations (MPOs), are increasingly focused on improving system efficiency and mitigating the negative environmental impacts of transportation.

The California Department of Transportation (Caltrans) is already responding to new mandates for efficient use of existing transportation infrastructure and reduction of negative environmental impacts. For example, Caltrans' Strategic Management Plan (SMP) 2015-2020 states that its new mission statement is to "*Provide a safe, sustainable, integrated, and efficient transportation system to enhance California's economy and livability*" (Caltrans, 2015a). In particular, the SMP Goal 3, titled "Sustainability, Livability and Economy," identifies measurable targets to help Caltrans achieve its mission. By 2020, Caltrans hopes to triple California's bicycle mode share, double both pedestrian and public transit mode shares, and lower both vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions by 15 percent each. Meeting these targets may require not only enhancing traditional transportation systems that govern public transit and private vehicle use but also planning for and recognizing the role of shared mobility as an innovative strategy in transportation planning and operations.

As part of SMP Goal 3, Caltrans must develop an accessibility and livability score as performance metrics by December 2016. The accessibility score will be determined by considering access to multi-modal options in relation to housing, jobs, etc. The livability score considers quality of life, environmental justice, and localized emissions. Percentage increases in the use of bicycling, walking, and public transit are also key performance metrics for the Department. Other related performance measures include reductions in VMT and GHGs. Furthermore, the role of sustainable transportation in corridor system master plans for all State routes is another performance measure, which must be completed by 2017. By 2020, the top 25 corridor system management plans must be finalized. It is worth exploring what role shared mobility could play in meeting the targets set in the SMP Goal 3 and whether shared mobility could be more directly tied to many of the State's energy and environmental policies including: AB 32 (California's Global Warming Solutions Act) and SB 375 (Sustainable Communities and Climate Protection Act).

Shared mobility is the shared use of a vehicle, bicycle, or other low-speed mode that enables users to have short-term access to transportation modes on an "as-needed" basis. Shared mobility includes carsharing; personal vehicle sharing (including peer-to-peer/P2P carsharing and fractional ownership); bikesharing; scooter sharing; shuttle services; carpooling and vanpooling; ridesourcing/transportation network companies (TNCs)—also known as ride-hailing; microtransit; and courier network services (CNS). Many studies have documented the impacts of shared mobility on numerous global cities (e.g., cost savings and convenience, reduced personal vehicle ownership, and VMT reductions). Nevertheless, more research is needed on a city or regional basis, as well as on newer services, such as ridesourcing/TNCs, microtransit, and CNS.

As the private sector innovates and the menu of shared mobility options grows, it is important for the public sector to not only respond with appropriate legislation to protect public safety but also to provide guiding policies to maximize benefits. In addition, transportation planners and operations managers will increasingly need to understand how shared mobility impacts transportation planning and how to maximize the potential to improve system efficiency. This white paper presents an overview of current shared mobility models and supporting smartphone apps. It is organized into nine sections including: 1) carsharing; 2) scooter sharing; 3) bikesharing; 4) on-demand ride services (ridesourcing/TNCs, ridesplitting, and e-Hail); 5) ridesharing; 6) alternative transit services (shuttles and microtransit); 7) courier network services; 8) trip planning apps; and 9) a summary. Figure 1, below, shows the key areas of shared mobility covered in this white paper.

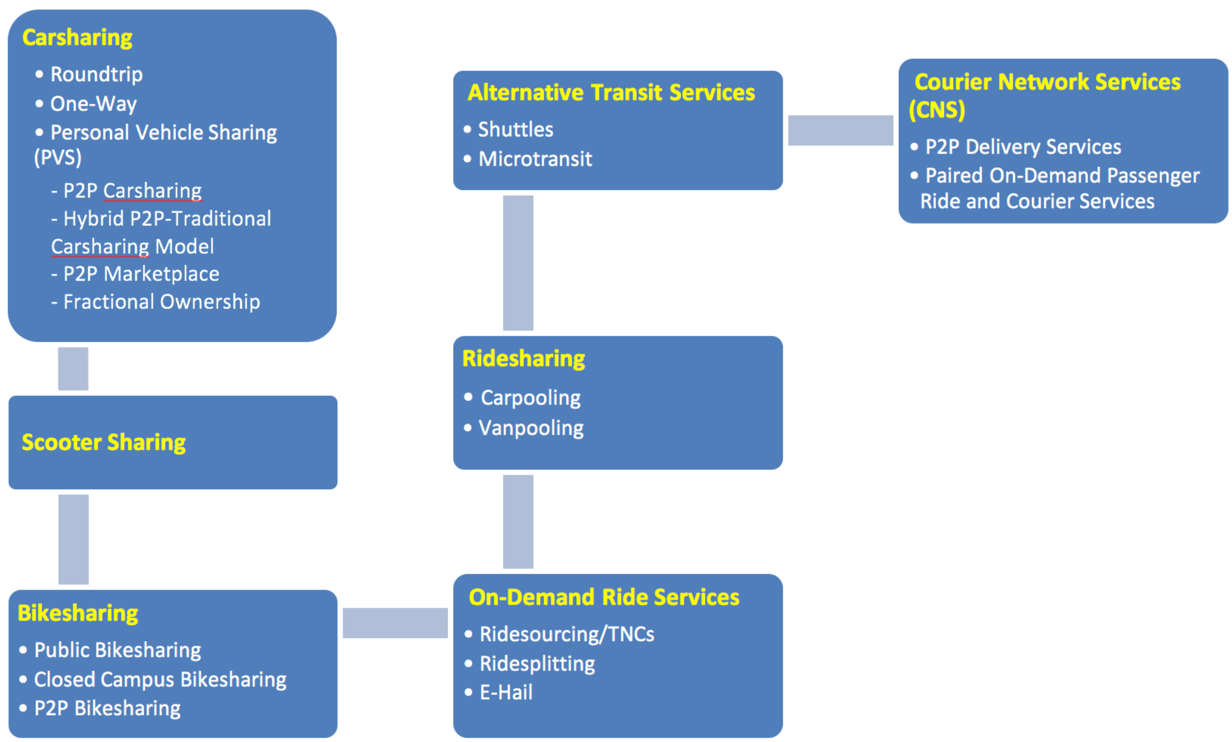

Figure 1: Key Areas of Shared Mobility

CARSHARING

The principle of carsharing is simple: individuals gain the benefits of private vehicle use without the costs and responsibilities of ownership. Rather than owning one or more vehicles, a household or business accesses a fleet of shared vehicles on an as-needed basis. The California Transportation Plan (CTP) 2040 discusses carsharing as a tool for achieving VMT and GHG reduction targets. The CTP 2040 predicts that if by 2040 there is a five-percent increase in the adoption of carsharing for short distance travel in California, there can be a statewide decrease in VMT by 1.1 percent (Caltrans, 2015b).

The benefits of carsharing directly align with some of the goals outlined in the SMP 2015. Because private vehicles stand idle for 95 percent of the time, carsharing can increase the efficiency of automobile use (Fraiberger and Sundararajan, 2015).

The first carsharing program launched in the United States (U.S.) in 1994, and the industry has grown rapidly since. As of January 2015, there were 23 carsharing operators in the U.S. with over 1.1 million members and 16,754 vehicles (Shaheen and Cohen, 2015). Recently, new carsharing service models have emerged in addition to roundtrip, including one-way carsharing and personal vehicle sharing models.

Roundtrip Carsharing

Roundtrip carsharing, the earliest carsharing service model, allows members hourly access to a fleet of shared vehicles. Notably, users must return vehicles to the same location from where they were picked up. The cost of using carsharing is a combination of annual or monthly fees, as well as time and distance costs. Annual fees for membership can range from $0 to $300, although most fall between $30 and $70. For periods lasting under 24 hours of use and distances under 50 miles, time costs can range from $3 to $11 per hour of use, and distance costs range between $0 and $0.49 per mile driven. Gas and insurance are normally included in these costs.

Numerous studies have documented that roundtrip carsharing reduces the number of vehicles on the road, VMT, GHG emissions, and transportation costs for individuals. A study of City CarShare members found that 30 percent of members shed one or more of their own personal cars, and two-thirds chose to postpone the purchase of another vehicle after using the service for two years (Cervero and Tsai, 2004). An aggregate-level study of 6,281 people who participated in carsharing programs in the U.S. and Canada documented these impacts: 25 percent of members sold a vehicle due to carsharing, and another 25 percent postponed purchasing a vehicle. The study concluded that one carsharing vehicle replaces 9 to 13 vehicles among carsharing members. This study also documented reductions in VMT (27 to 43 percent) and in GHG emissions (a 34 to 41 percent decline or an average reduction of 0.58 to 0.84 metric tons/household) (Martin and Shaheen, 2011). It is important to note that aggregate-level data cannot necessarily be generalized on a city or regional basis, as this analysis reflects the combined impacts across the U.S. and Canadian study populations.

Roundtrip neighborhood carsharing has also had a notable impact on modal shift. Martin and Shaheen (2011) examined the impact of carsharing on public transit and non-motorized travel. While they found a slight overall decline in public transit use, carsharing members exhibited a significant increase in alternative modes, such as walking, bicycling, and carpooling. A case study in Montreal, Canada found that carsharing members have a modal split with auto usage significantly lower than that of non-carsharing members (Sioui et al., 2013). Furthermore, numerous studies of roundtrip carsharing in North America found that members saved an average of $154 to $435 per month per carsharing household when compared to their private vehicle-use expenses (Shaheen et al., 2012a). Businesses can also sign up for carsharing, providing at-work mobility options for their employees. A recent aggregate-level study of Zipcar for Business members showed that two in five members sold or avoided buying a vehicle due to joining Zipcar through their employers (Shaheen and Stocker, 2015). Some aggregate-level carsharing impacts for North America are summarized in Figure 2, below.

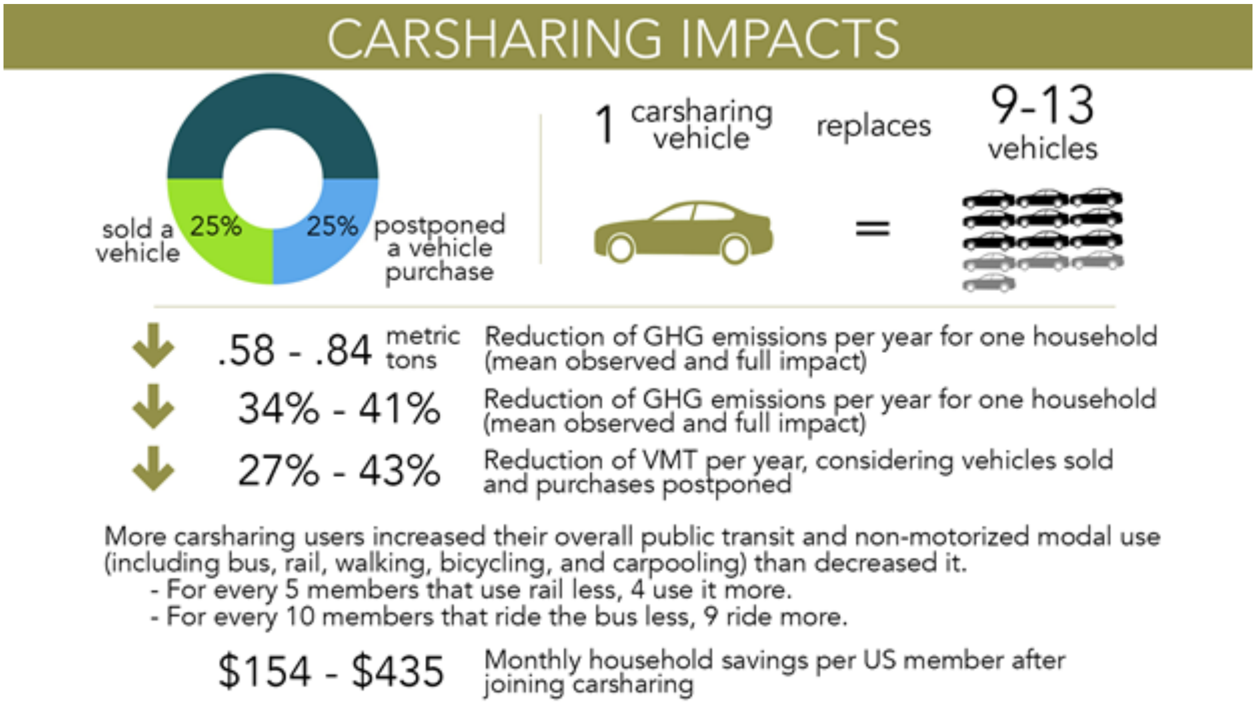

Figure 2: Impacts of Roundtrip Carsharing (graphic excerpted from Shaheen and Chan (2015))

It is important to note that carsharing succeeds because it either provides consumers with better mobility or sufficient mobility at reduced cost. The latter effect drives most of the emission and fuel use reductions with travel substitutions replacing private vehicle use. Carsharing fundamentally changes the cost structure of driving from a fixed cost to a variable cost. As this involves substituting “driving with driving” (i.e., private auto with fixed costs vs. shared vehicle with variable costs), the magnitude of these changes must be measured to assess the fundamental carsharing impact. This is challenging, given that we do not know who will join carsharing until after they have enrolled. Among the carsharing member population, we need to know: 1) how individuals traveled before and what modal behaviors they changed due to carsharing and 2) how individuals would have traveled in the absence of carsharing (e.g., postponed vehicle purchase). These effects are nearly impossible to measure without some form of member survey, as the best way to understand these shifts is to ask what happened. Activity data can only tell us how an individual used a particular shared mode in contrast to their total transportation behavior.

The application of data from national and regional travel surveys to the evaluation of shared mobility impacts is currently less feasible for a number of reasons. First, these surveys are generally snapshots of activity over large areas that may or may not have a robust range of shared mobility services. They generally lack longitudinal structure, which span the period before and after a person begins using a system. Second, the subsample of people using shared mobility services within large surveys, such as the National Household Travel Survey (NHTS), is small, and the time between such surveys can be large—spanning years. People are rarely re-sampled in subsequent surveys. Because of these factors, use of national and regional surveys to evaluate the household-level change in behavior is limited at present and likely to remain so at least into the near future.

The member is best positioned to report the impact that carsharing has had on their lives. From this stated response data, we generate an understanding of an individual’s travel lifestyle before he/she joined, including miles driven in personal vehicles, which is often challenging to gauge. In addition, the shifts that are made as a result of carsharing are different for different people. Many individuals will invariably drive marginally more, and we often see that many do as a result of carsharing. Others will drive substantially less, as they alter their engagement with the private auto to one of necessity rather than convenience. The measurement of this effect through surveys is required because only the member can truly assess how the system has changed his/her life. For some, the impact of the system is inconsequential, and observed behavioral changes are the result of other unseen dynamics of which carsharing is merely a witness. For others, the system plays a central role in facilitating a lifestyle change that reduces aggregate fuel consumption and emissions. The member survey, although imperfect in its imprecision of measuring changes in big numbers, is an important instrument for obtaining a before-and-after measure of carsharing impacts. For this reason, despite advances in technology that improve approaches to travel behavior measurement (i.e., activity data), surveys are and likely will continue to play a fundamental role in assessing causes of change and providing critical inputs to its measurement. A similar discussion is relevant to impact analyses of the other shared modes discussed in this white paper.

One-Way Carsharing

One-way carsharing (also known as point-to-point carsharing) allows members to pick up a vehicle at one location and drop it off at another. One-way carsharing experienced a rapid worldwide expansion during 2012, operating in seven countries, including the U.S. and Canada (Shaheen and Cohen, 2012). As of January 2015, 35.7 percent of North American fleets were one-way trip capable, and 30.8 percent of members had access to these fleets (Shaheen and Cohen, 2015). As of September 2015, four carsharing companies offer one-way functionality (car2go, DriveNow, Zipcar, and BlueIndy) in 14 U.S. metropolitan regions. DriveNow charges $12 for the first 30 minutes of vehicle use and $0.32 per minute thereafter, and car2go charges an annual fee of $35 and $0.41 per minute of use. Zipcar charges $0.20 per minute of use in addition to its annual fee. BlueIndy has several membership plans, but its one-day plan costs $8 for the first 20 minutes of use and $0.40 per minute thereafter. One-way carsharing can allow increased flexibility and has the potential to further enhance first- and last-mile connectivity. First- and last-mile connectivity is a key issue identified in both the SMP 2015 and CTP 2040.

Personal Vehicle Sharing (PVS)

Personal vehicle sharing (PVS) is another carsharing service model characterized by short-term access to privately-owned vehicles. It is often also referred to as peer-to-peer (P2P) carsharing, although this is a distinct type of PVS. PVS companies broker transactions among car owners and renters by providing the organizational resources needed to make the exchange possible, such as an online platform, customer support, automobile insurance, and vehicle technology. Members access vehicles through a direct key transfer from the owner to the renter or through operator-installed in-vehicle technology that enables unattended access. There are four distinct models of personal vehicle sharing: 1) P2P carsharing, 2) hybrid P2P-traditional carsharing, 3) P2P marketplace, and 4) fractional ownership (Shaheen et al., 2012a).

P2P Carsharing

Peer-to-peer carsharing employs privately-owned vehicles or low-speed modes made temporarily available for shared use by an individual or members of a P2P company. While still heavily focused in urban areas and cities, P2P carsharing operations are not as geographically confined as other types of carsharing because the users provide the floating vehicle fleet. In addition, P2P carsharing appears to serve a more diverse population than traditional station-based carsharing services. In a study of P2P carsharing use in Portland, it was found that 37 percent of families in poverty live in a census block group that contains at least one P2P vehicle, but only 13 percent live in a census block that has a station-based carsharing vehicle. In parts of East Portland, P2P vehicles are the only type of carsharing vehicles available (Dill, 2014). Furthermore, Fraiberger and Sundararajan (2015) project that P2P carsharing will have more pronounced impacts on below-median income consumers than above-median income consumers. Examples of P2P carsharing operators in the U.S. include: RelayRides, Getaround, and FlightCar. Pricing and rental terms for P2P carsharing services vary, as they are typically determined by vehicle owners listing their vehicles for rent. The P2P carsharing operator generally takes a portion of the rental amount in return for facilitating the exchange and providing third-party insurance. For example, RelayRides takes 25 percent commission from the owner along with 10 percent from the renter, and Getaround takes 40 percent from the owner for its services. With FlightCar, the car owner is paid $.05 to $.20 per mile, with an average payment of $20 to $30. There are no parking fees at the airport, and the vehicle is washed and vacuumed when the owner picks it up upon return. There also is a flat-rate monthly program in which the driver can net a total of $250 or greater. As of May 2015, there were eight active P2P operators in North America, with two more planned to start in the near future.

Hybrid P2P-Traditional Carsharing and P2P Marketplace
Hybrid P2P-traditional carsharing is where individuals access vehicles or low-speed modes by joining an organization that maintains its own fleet, but it also includes private autos or low-speed modes throughout a network of locations. P2P marketplace enables direct exchanges among individuals via the Internet, including pricing agreements. Terms are generally decided between parties of a transaction, and disputes are subject to private resolution.

Fractional Ownership
In the fractional ownership model, individuals sublease or subscribe to a vehicle owned by a third party. These individuals have “rights” to the shared vehicle service in exchange for taking on a portion of the operating and maintenance expenses. This enables access to vehicles that individuals might otherwise be unable to afford, and it results in income sharing when the vehicle is rented to non-owners. Fractional ownership could be facilitated through a dealership or a partnership with a carsharing operator. Often, fractional ownership is used with luxury cars, which would otherwise be unaffordable for most, as well as for recreational vehicles (RVs) in recent years. At present, this segment of the industry is small, and it remains to be seen whether or not fractional ownership can compete with existing carsharing models and personal vehicle ownership overall.

Fractional ownership companies in the U.S. currently include: Curvy Road, Gotham Dream Cars, and CoachShare. In December 2014, Audi launched its “Audi Unite” fractional ownership model in Stockholm, Sweden. Audi Unite offers multi-party leases with pricing based on model and yearly mileage (2,000 or 3,000 Scandinavian mile packages available). The number of drivers ranges from two to five. For example, an Audi Unite A3 sedan can be leased among five drivers for approximately 1,800 kronors per month (~$208 USD per driver per month) for 2,000 annual Scandinavian miles (~12,000 statute miles) on a 24-month lease.

SCOOTER SHARING

A more recent innovative vehicle sharing model that has emerged is scooter sharing. As of September 2015, there were several scooter sharing systems in Europe and two in the United States: Scoot

Networks in San Francisco, California and Scootaway in Columbia, South Carolina. In Europe, Motit in Barcelona launched in 2013 with 50 scooters, and Enjoy in Milan launched in July 2015. All of these systems offer one-way and roundtrip short-term scooter sharing, which includes insurance and helmets. Scootaway scooters run on gasoline, which is included within the price of the rental. Several other systems are in trial phases in Europe including: CityScoot in Paris, eMio in Berlin, and Scoome in Munich and Cologne. In addition to scooter sharing (classic and cargo models), Scoot Networks also offers electric motorcycle sharing and Scoot Quads (Renault's small electric vehicle, called the Twizy). From its launch in 2012 through April 2014, Scoot Networks increased from four to 12 stations and 20 to 50 scooters, respectively. As of October 2015, Scoot had over 400 scooters in its network, and Scootaway's fleet comprised of 350 scooters as of September 2015. As of October 2015, Scoot's vehicles were being driven over 70,000 miles each month (Scoot, unpublished data).

Scoot users have two pricing options: 1) $4 per every half hour of use with no monthly fee or 2) $19 per month and usage billed at $2 per an hour. In October 2015, Scoot introduced ten four-wheeled, two-seater "Twizy" vehicles into its fleet from Renault (branded as Nissan in the United States), priced at $8 per half hour of use (Scoot, unpublished data, 2015). Scootaway, located in South Carolina, bills at a flat rate of $3 per half hour of use (Scootaway, unpublished data, 2015).

BIKESHARING

Bikesharing has emerged as one of the latest and fastest growing transportation innovations in many North American cities. Bikesharing systems allow users to access bicycles on an as-needed basis from a network of stations, which are typically concentrated in urban areas. Bikesharing stations are usually unattended and accessible at all hours, granting an on-demand mobility option. Most bikesharing operators are responsible for bicycle maintenance, storage, and parking costs. Bikesharing can also be free floating within a geo-fenced area either through a business-to-consumer (B2C) operator (e.g., Social Bicycles) or through P2P systems enabled through third-party hardware and applications (e.g., Bitlock, Spinlister). There are three main types of bikesharing systems: 1) public bikesharing, 2) closed campus bikesharing, and 3) P2P bikesharing (Shaheen and Christensen, 2014). The majority of bikesharing systems in U.S. cities are public, with anyone able to access a bicycle for a nominal fee (with a credit/debit card on file). Recent changes to the Payment Card Industry Data Standard (PCI DSS), such as chip cards, may impact how shared mobility credit and debit card data are stored and processed. With a chip card, a unique one-time code is generated to create a transaction handshake. The one-time code is intended to prevent counterfeiting credit and debit card information.

As of October 2015, there were 61 information technology-based public bikesharing systems in the U.S. (spread over 87 cities), with approximately 30,750 bikes and 3,200 stations (Russell Meddin, unpublished data). Closed-campus bikesharing systems are increasingly being deployed at university and office campuses, and they are only available to the particular campus community they serve. P2P bikesharing services are available in urban areas for bike owners to rent out their idle bikes for others to use and are also growing due to companies, such as Spinlister and Bitlock.

Shaheen et al. (2012b and 2014) conducted a two-part study of public bikesharing programs in North America to determine the program impacts on modal split. The results suggest that public bikesharing in larger cities takes riders off of crowded buses, while bikesharing in smaller cities improves access/egress from bus lines. Moreover, respondents reported that rail usage decreased in larger cities due to faster travel speeds and cost savings from bikesharing. Half of all bikesharing members reported reducing their personal automobile use (Shaheen et al., 2014). A 2012 survey of 20 U.S. public bikesharing programs found the average cost for a day pass to be $7.77, and all the programs offered the first 30 minutes of riding free. Twelve programs offered monthly memberships, averaging $28.09 per month. Eighteen of the programs offered annual memberships, which cost an average of $62.46 (Shaheen et al., 2014). Aggregate-level impacts of bikesharing are summarized in Figure 3, below, based on a number of cities analyzed in North America.

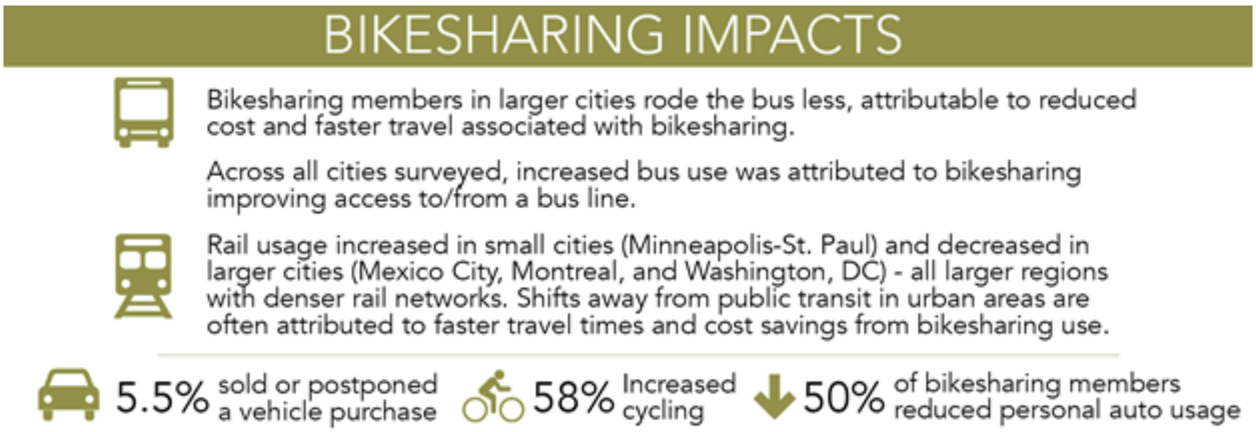

Figure 3: Impacts of Public Bikesharing (graphic excerpted from Shaheen and Chan (2015))

ON-DEMAND RIDE SERVICES

On-demand ride services have experienced notable growth in the last few years, but they face an uncertain regulatory and policy climate. They include ridesourcing or transportation network companies (TNCs), ridesplitting within these TNC services, and e-Hail services for taxis with medallions.

Ridesourcing / Transportation Network Company (TNC) Services

Ridesourcing or TNC services use smartphone apps to connect community drivers with passengers. There are various terms used for this emerging transportation option including: ridesourcing, TNCs, ride-hailing, and ride-booking. Examples of for-hire vehicle services include taxis, Lyft, Sidecar, uberX, as well as specialized services such as Lift Hero and Shuddle (described below). As of August 2015, Lyft was operating in 60 U.S. cities with over 100,000 drivers, and Uber was operating in 59 countries in over 310 cities with approximately 162,000 drivers. Sidecar operates in approximately 10 U.S. cities. In the San Francisco Bay Area, uberX charges $3.20 as a base fare (including a "Safe Rides fee"), $0.26 per minute, and $1.30 per mile during non-surge times. Also in the Bay Area, Lyft charges a base fare of $3.80 (includes a "Trust and Safety fee"), $0.27 per minute, and $1.35 per mile. In San Francisco, Sidecar charges a base fare of $3.00, $0.23 per minute, and $1.13 per mile. The prices mentioned are during non-peak or surge times—prices usually go up during periods of high demand to incentivize more drivers to take ride requests.

Lift Hero is a specialized for-hire vehicle service that targets the disabled population and older adults. The drivers are specially trained in the care for such users. Lift Hero's on-demand ride service is available in the San Francisco Bay Area. It costs $25 per hour and $1 per mile. Lift Hero also provides a "concierge" service, which is available throughout California. This service charges $4, along with 2.9

percent of the fare, in return for calling a Lyft or Uber for older adults who are not comfortable using a smartphone. Another specialized for-hire vehicle service is Shuddle, which provides rides for children either to or from school or afterschool activities. The drivers are either mothers or those with a background in childcare. At present, Shuddle is only available in the San Francisco Bay Area and charges $12 to $15 for rides under five miles.

Ridesplitting

Ridesplitting involves splitting a ridesourcing/TNC-provided ride with someone else taking a similar route. Lyft and Uber match riders with similar origins and destinations together, and they split the ride and the cost. Recent examples of ridesplitting are Lyft Line and UberPOOL. These shared services allow for dynamic changing of routes as passengers request pickups in real time. Lyft Line has experimented with "Hot Spots" in the San Francisco Bay Area that encourage passengers to congregate at select intersections in exchange for discounted fares as a means of consolidating operations and making them more efficient. Similarly, UberPOOL has recently been testing "Smart Routes," where users can get a discounted fare starting at $1 off the normal UberPOOL price in return for walking to a major arterial street. This allows drivers to make fewer turns and complete ride requests faster (de Looper, 2015).

E-Hail Services

In the wake of the rise in ridesourcing/TNCs, the taxi industry has also been modernizing. Taxis can now be reserved by an "e-Hail" Internet or phone application maintained either by the taxi company or a third-party provider. In some cases, even pedicabs can be hailed through a mobile application (e.g., St Pete Pedicab). There has been a dramatic increase in taxi use of e-Hail services, such as Arro, Curb, Flywheel, Hailo, and iTaxi. For example, as of October 2014, the e-Hail service Flywheel claimed 80 percent of San Francisco taxis (1,450 taxis) were using their app, which has brought taxi wait times closely in line with those of ridesourcing/TNCs (Steinmetz, 2014). Increasingly, taxi and limousine regulatory agencies are developing e-Hail pilot programs and mandating e-Hail services. As of February 2015, Flywheel was operating in six cities with over 5,000 drivers, and Curb was serving approximately 60 U.S. cities with 35,000 cabs. All the aforementioned e-Hail services charge locally regulated taxi rates and do not use "surge pricing" during periods of high demand, as TNCs are prone to do. At present, in San Francisco, licensed taxis charge a base fare of $3.50, $0.55 per minute of traffic delay, and $2.75 per mile regardless of high demand times. However, Flywheel, similarly to TNCs, charges its users $5 if they cancel a ride request more than two minutes after placing it. Flywheel also charges a $1.00 service fee in addition to each fare.

Since ridesourcing/TNCs and e-Hail solutions are relatively new service models, few studies document their travel behavior impacts. TNCs have conducted internal studies of user and travel activity; however, those data remain proprietary. Rayle et al. (2014) conducted an early exploratory study of 380 ridesourcing/TNC users in San Francisco, California during Spring 2014. The findings are summarized in Figure 4, below. Researchers found that ridesourcing/TNC users were generally younger and more highly educated than the city average (84 percent had a bachelor's degree or higher). uberX provided the majority of trips (53 percent), while other Uber services (black car, SUV) represented another eight percent. Lyft provided 30 percent of trips, Sidecar seven percent, and the remainder of trips were provided by other services. Forty percent of ridesourcing/TNC users who owned a car stated that they had reduced their driving due to the service.

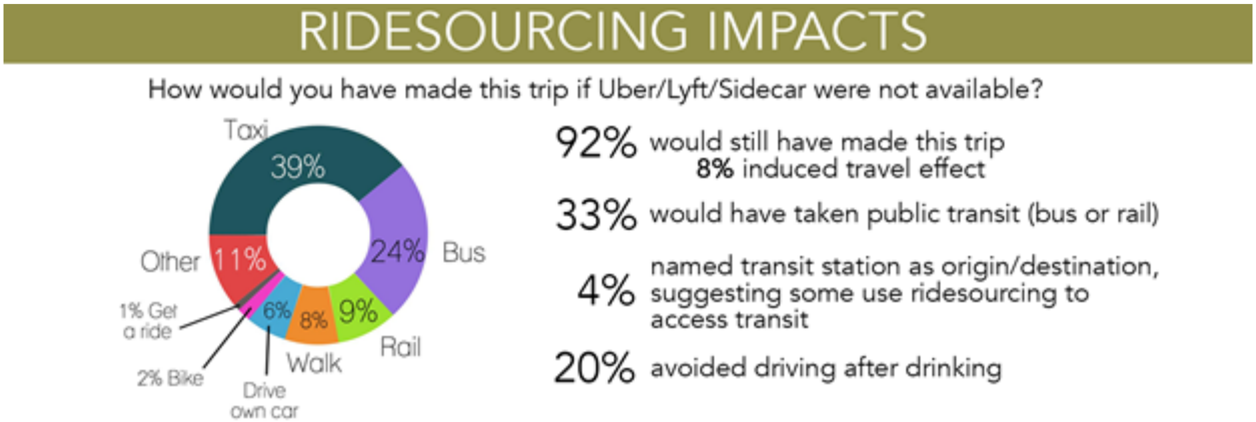

Figure 4: Impacts of Ridesourcing/TNCs (graphic excerpted from Shaheen and Chan (2015))

RIDESHARING: CARPOOLING AND VANPOOLING

Ridesharing facilitates shared rides between drivers and passengers with similar origin-destination pairings. Ridesharing includes vanpooling and carpooling. Vanpooling is classified by the Federal Highway Administration (FHWA) as a grouping of seven to 15 persons commuting together in one van, whereas carpooling involves groups smaller than seven traveling together in one car. Ridesharing can be classified under several categories: 1) acquaintance-based, 2) organization-based, and 3) *ad hoc*. Acquaintance-based ridesharing consists of carpools that are formed by people who are already acquaintances (i.e., carpools among family ("fampools") and coworkers). Organization-based carpools require participants to join the service either through membership or by visiting a website. *Ad hoc* ridesharing involves more unique forms of ridesharing, including casual carpooling—also known as "slugging" (Chan and Shaheen, 2012). Ridesharing's modal share has declined since the 1970s in the U.S. In 1970, 20.4 percent of American workers commuted to work by carpool, according to the U.S. Census. According to the American Community Survey, the modal share has declined to a low of 9.3 percent as of 2013, but it still remains the second largest travel mode in the U.S. after driving alone (U.S. Census Bureau, 2013).

Carpooling and vanpooling have the added benefit of reducing driver costs. A vanpool could cost between $100 and $300 per person per month, although this varies considerably depending on gas prices, local market conditions, and government subsidies (Martin, unpublished data). Flexible carpoolers could save two-thirds the cost of commuting alone in a single-occupancy vehicle (Dorinson et al., 2009).

Carpooling and vanpooling have been identified by the CTP 2040 as key shared mobility strategies to achieving Caltrans' ambitious VMT and GHG reduction goals. The CTP 2040 states that if by 2040 there is a five percent increase in the adoption rates of carpooling, there would be a 2.9 percent reduction in VMT. It further calculates that if California converts all its 2+ HOV lanes to 3+, a reduction in VMT by 0.8 percent could be achieved. The CTP also acknowledges the advent of what it calls "peer-to-peer ridesharing," where drivers and passengers can connect efficiently using the Internet (Caltrans, 2015b). Carma Carpool and Scoop are examples of these services.

ALTERNATIVE TRANSIT SERVICES

Many transportation options have existed in parallel to established public transit networks including: jitneys, dollar vans, paratransit, and shuttles. While these services can target special populations, they are often inefficient and costly to the service provider. There has recently been increased attention on mobility options that can serve as alternatives to public transportation networks, including shuttles and microtransit.

Shuttles

Shuttles are shared vehicles that can connect passengers to public transit stations or to employment centers. They can also act as replacement services for public transit lines that are undergoing repairs or maintenance. They have historically focused on the "first- and last-mile" problem, ferrying people to/from suburban residences or job centers from/to public transit stations. One example of a shuttle service is a distributer/circulator service, which can connect areas in urban cores that are relatively close in proximity but too far to be walking distance. These services are often free or low cost for the user. An example of this is the Emery-Go-Round, which operates in Emeryville, CA and connects Emeryville to a Bay Area Rapid Transit (BART) station.

In addition to circulator shuttles, employer shuttles have expanded rapidly in the past decade. In recent years, there has been increased attention on employer shuttles and their interplay with the public transit network. Dai and Weizimmer (2014) found that employer shuttles are attractive due to time and cost savings for commuters, but they may also contribute to a job-housing imbalance by enabling commuters to live farther from their workplace. Additionally, private employer shuttles may divert ridership from public transportation.

A 2011 San Francisco County Transportation Authority (SFCTA) survey found that 63 percent of shuttle passengers would drive alone, if the shuttle service were not provided. Moreover, these shuttles produce only 20 percent of the emissions that would have been emitted by the vehicles they take off the road. This study also found that employer shuttles draw approximately 20 percent of their demand from existing public transportation routes. Finally, the study concluded that employer shuttles yielded a net reduction of vehicles on Bay Area roads (SFCTA, 2011).

Microtransit

In addition to shuttles, a more technology-enabled type of alternative transit service has recently emerged called microtransit, which can incorporate flexible routing, flexible scheduling, or both. These services operate much like jitneys of the past but are enhanced with information technology (Cervero, 1997). Existing microtransit operators target commuters, primarily connecting residential areas with downtown job centers. However, there are opportunities for microtransit services to either expand into the paratransit space or for paratransit to innovate along similar lines. Microtransit's use of smartphone technology avoids traditional and costly methods of booking rides, such as call centers or even booking websites. The use of advanced technology has the potential to lower operating costs for services that target special populations, such as disabled, older adults, and low-income groups.

Microtransit services typically include one or more of the following service characteristics (these are a variation of the characteristics attributed to "flexible transit services" by TCRP, 2004):

1) Route deviation (vehicles can deviate within a zone to serve demand-responsive requests);
2) Point deviation (vehicles providing demand-responsive service serve a limited number of stops without a fixed route between spots);
3) Demand-responsive connections (vehicles operate in a demand-responsive geographic zone with one or more fixed-route connections);
4) Request stops (passengers can request unscheduled stops along a predefined route);
5) Flexible-route segments (demand-responsive service is available within segments of a fixed-route); and
6) Zone route (vehicles operate along a route corridor whose alignment is often determined based on user input, with fixed departure and arrival times at one or more end points).

Microtransit services can include variations of the following two models: 1) fixed route, fixed schedule (can be similar to the operations of public transit) and 2) flexible route with on-demand scheduling (this more closely mirrors ridesplitting and paratransit services).

Fixed, Pre-Determined Routes and Fixed Schedules
An example of a fixed-route microtransit service is Chariot, which operates similar to a public transit service by running 15-seater vans along predefined routes. However, customers can make requests for new “crowdsourced” routes to be created based on demand. As of October 2015, Chariot operates seven predefined routes in San Francisco and plans to open another route in November, in addition to others as user-demand grows or shifts. Fares range from $3 to $6 on select routes. The service also conforms to the IRS “transit pass” standard, so passengers can pay using pre-tax commuter benefits, thereby lowering the effective fare.

While these services are somewhat similar to vanpools, microtransit vehicles have employed drivers (whereas vanpool passengers often share driving responsibilities). Because of their more rigid nature (fixed routes and fixed schedules), these services mirror public transit more closely and could represent more direct competition. It is important to note, however, that Chariot serves about 700 to 1,000 people per day, at present, whereas the 38-Geary Muni bus lines serve over 33,000 riders a day (Fehr & Peers, 2015). Thus, the impact of many microtransit services is still limited.

Flexible Routes and On-Demand Scheduling
An example of on-demand microtransit is Boston-based Bridj, a mobile application that enables customers to request a ride in select neighborhoods from 14-seater vans. After the Bridj system receives pickup requests, its algorithm sets a central passenger meeting spot based on the location of the most recent requests. Customers then walk to the meeting spot and share a ride with other passengers that have a similar route or destination as defined by the algorithm. The service claims to be moving 22 passengers per vehicle per hour. It has recently expanded services to include select neighborhoods in Washington D.C., and fares range between $3 to $6, at present (Stromberg, 2015). As with Chariot, Bridj passengers can pay the fare using pre-tax commuter benefits.

Another on-demand microtransit service that has emerged is Via, which is operational in New York City. It has completed 1.5 million rides since launching in late-2013. As with Chariot and Bridj, this service also conforms to the IRS “transit pass” standard. Via users can request rides in real time and expect a shared vehicle to pick them up within minutes with other travelers going in a similar direction. Due to the large number of one-way streets in New York City and to improve operational efficiency, riders may be asked to walk to an adjacent one-way avenue so that the shared vehicles do not have to make inefficient route deviations on opposing one-way avenues. The service is fully dynamic, as it does not have any static routes or schedules and reroutes its vehicles based on traffic and demand. At present, Via charges a flat fare of $5 to $7, depending on the booking method (de Looper, 2015).

COURIER NETWORK SERVICES

Courier Network Services (CNS) (also referred to as flexible goods delivery) provide for-hire delivery services for monetary compensation using an online application or platform (such as a website or smartphone app) to connect couriers using their personal vehicles, bicycles, or scooters with freight (e.g., packages, food). Although the business models in this realm are evolving, two general models appear to have emerged: 1) P2P delivery services and 2) paired on-demand passenger ride and courier services.

P2P Delivery Services

In P2P courier network services, anyone who signs up can use their private vehicle or bike to conduct a delivery. Within P2P delivery services, there are a variety of business models. Postmates couriers, for example, operate on bikes, scooters, or cars. They deliver groceries, takeout, or goods from any restaurant or store in a city. They charge a delivery fee in addition to a nine percent service fee based on the cost of the goods being delivered. Instacart is similar to Postmates, but it is limited to grocery delivery and charges a delivery fee between $4 to $10 depending on the time given to complete the delivery. It has begun to allow some of its couriers to be classified as part-time employees. DoorDash is a service where one can be paid a flat delivery fee of $7 in return for going to a restaurant and delivering to the requester’s home or office. Roadie is another courier service, but it is used more for inter-city goods movement rather than same-day intra city deliveries. Finally, Shipbird is a shipping service that connects everyday commuters with individuals seeking couriers. Couriers provide the Shipbird app with their availability, commuting route, and the distance they are willing to deviate from their commute route in order to complete a delivery. The algorithm then matches these couriers with the requested delivery jobs. P2P delivery services make use of existing personal vehicles to get items delivered. The proliferation of these services—where couriers use their personal travel modes—could reduce the need for delivery companies to maintain their own fleet for operations.

Paired On-Demand Passenger Ride and Courier Services

The second CNS model that has emerged is one in which for-hire ride services (e.g., TNCs) also conduct package deliveries. Deliveries via these modes can either be made in separate trips or in mixed-purpose trips (e.g., for-hire drivers can transport packages and passengers in the same trip). As of now, Sidecar is the only TNC that conducts mixed-purpose trips in addition to dedicated goods delivery trips. As of February 2015, the company claimed that 10 percent of its passenger rides in San Francisco included package deliveries (Lien, 2015). Sidecar’s goods delivery service is called Sidecar Deliveries, where drivers can act as dedicated couriers without carrying a passenger. Sidecar Deliveries also has included walkers, as well as couriers on bicycle and scooter into its network. They claim to have cut pick up times by 75 percent. The service has partnered with Yelp Eat24, a food ordering service, to assist with deliveries. The company claims to have cut estimated delivery times in half.

Uber has also entered the food and goods delivery services market with UberEATS (food) and UberRUSH (bike, foot, and vehicle messenger delivery service). UberEATS charges a $3 flat delivery fee ($4 in New York City) in addition to the cost of the food, while UberRUSH charges a 20 percent delivery fee in New

York City and 25 percent in San Francisco and Chicago. Uber piloted UberRUSH in New York City in 2014, first as a bike messenger service where couriers would pick up an item from the requester and deliver it somewhere within a coverage area within the same day. This is now being expanded to merchant delivery, where items are picked up from stores and delivered either to the requester or to a third party by foot or vehicle, and it has recently expanded to San Francisco and Chicago (Cuthbertson, 2015). Uber is also experimenting with UberCARGO in Hong Kong for moving and delivery needs (e.g., mattress delivery to a new house) (Russell, 2015). For one day in June 2015, Lyft ran a promotion with Starbucks where they delivered free iced coffee. Thus, the three major ridesourcing/TNC operators have in some form tried expanding their ride services to include package/item delivery, food delivery, or both.

In the next section, smartphone or trip planning apps are featured, as they play a key role in enabling shared mobility services. The authors distinguish between single-mode trip planning and multi-modal trip aggregators below.

TRIP PLANNING APPS

Trip planning apps can assist travelers in identifying their preferred travel route and mode based on cost, environmental impact, and time considerations. They can also provide step-by-step assistance as users navigate their chosen route. In this way, they can act as enabling technology for the use of shared mobility modes. Initial research indicates that 80 percent of users of such apps used modes other than their personal cars, mostly opting for public transit (Gossart and Whitney, 2014).

Trip planning apps can be grouped into two general categories: 1) single mode trip planning and 2) multi-modal trip aggregators. Beyond simply suggesting environmentally-friendly travel modes, some apps, such as Waze and Metropia, employ gamification to incentive positive behaviors with rewards and points. The vast majority of trip planning apps, including those discussed below, can be downloaded and used free of charge.

Single-Mode Trip Planning

Trip planning apps that are designed for a particular mode include public transit and driving route-assistance apps. Increasingly, most mobility apps are using real-time information. Transit trip planning apps augment maps and timetables with real-time information about delays. For example, the Embark iBART app provides real-time information about BART, although it does not provide information about other connecting modes. The DC Metro also has its own app that provides real-time delay information about its trains. Driving-related single mode apps include Waze and Metropia. These apps use real-time traffic congestion and incident data to generate optimal routes for travelers, and they also give turn-by-turn assistance during the journey. The turn-by-turn guidance is similar to Google Maps and Apple Maps, although those applications also show modes other than driving when generating routes for the user.

Multi-Modal Trip Aggregators

Multi-modal trip aggregators offer a single platform for planning trips involving different modes including: public transit, taxi services, carsharing, ridesharing, on-demand ride services, bicycling, walking, and personal vehicles. Travelers can quickly view the time, cost, and even calories burned while using different modes and routes. These apps also use real-time information to provide accurate departure and arrival times. Examples of trip aggregation apps include: Citymapper, Nimbler, RideScout, Swyft, and TripGo.

Citymapper consolidates real-time information for public transit, walking, biking and ridesourcing/TNCs in the cities it covers. The app allows users to set arrival and departure times and provides suggestions based on travel time, cost, mode choices, and calories burned. Users can choose which modes to search for and filter results based on cost and arrival time.

Nimbler is another trip planning app that provides turn-by-turn directions, taking into account travel by bike, train, bus, and walking. The app shows real-time traffic and public transit delays when providing route options. For bicyclists, the app also allows users to set preferences related to the fastest, safest, or flattest route (Anderson, 2013).

RideScout, shown in Figure 5, launched in November 2013. It helps plan trips by comparing different route/mode options based on the approximate cost, calories burned, departure and arrival times, and trip duration. The application has links to third-party apps to complete bookings. RideScout also allows users to create itineraries for their day and then creates routes and schedules to help the user arrive on time. RideScout estimates that by 2018, they will have more than four million users, which will save 2.4 million tons of carbon dioxide (CO2) and remove the equivalent of 427,000 cars from the road each year (Gossart and Whitney, 2014). RideScout acquired GlobeSherpa in Summer 2015, which enables integrated mobility payment across modes.

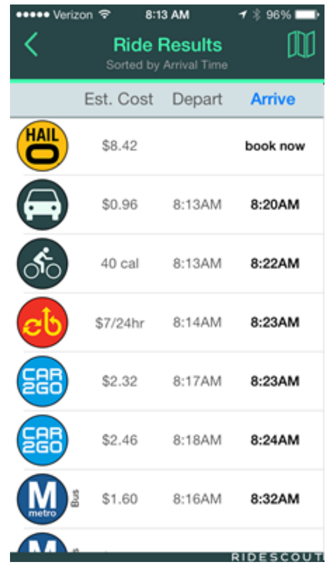

Figure 5: RideScout

Swyft is another trip planning app that uses *real-time* arrival information and cost to generate route/mode options. It is set to launch in San Francisco in September 2015. It combines Muni, BART, Uber, and walking. It also allows users to input overcrowding and delay information real time to alert other Swyft users seeking to travel the same route or mode.

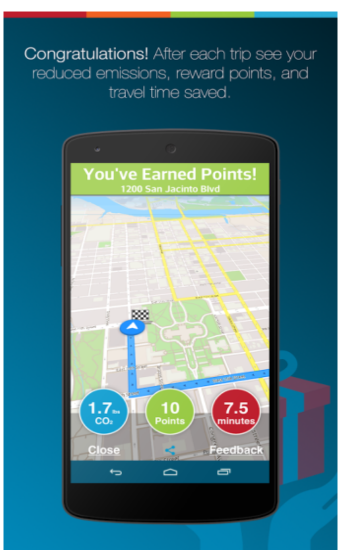

Figure 6: Example of gamification in Metropia

TripGo allows the user to set their relative priorities among cost, travel time, GHG emissions, and convenience. The app integrates public transit, ridesharing, carsharing, personal vehicle driving, bikesharing, etc. and allows the user to select desired modes. Like RideScout, TripGo enables users to input their personal schedule and create routes based on that schedule.

Gamification

Some mobile apps have developed incentives to reduce congestion. These apps employ gamification to incentivize more environmentally-friendly travel modes. Waze gives its users points for providing traffic data and warnings of road hazards (construction, cops, cameras) for other drivers. *Metropia,* shown in Figure 6, provides routes for commuting, but it also offers incentives for people to take alternative routes and departure times to reduce traffic on certain routes. Incentives include online music, gift cards to local and online shops, etc. The app also tracks how many pounds of CO_2 the user saves. A Metropia pilot study on its users in Los Angeles found that after six weeks of use, 86 percent of commuters reported saving time, and over 60 percent of users changed their regular departure time. Users who changed their departure time and route experienced between a 20 and 30 percent reduction in commute times (Hu et al., 2014).

SUMMARY

Shared mobility is an innovative transportation strategy that enables users to gain short-term access to transportation modes on an as-needed basis for either passenger trips or goods delivery. The advent of carsharing, bikesharing, ridesourcing/TNCs, and other innovative mobility services is changing how urban travelers, in particular, access transportation. In the future, these options could spread more to suburban and rural locations, particularly with the arrival of connected and automated vehicle technology.

Numerous studies of shared mobility have documented a number of environmental, social, and transportation-related impacts, such as the reduction of vehicle use, ownership, and vehicle miles traveled. Cost savings and convenience are frequently cited as popular reasons for shifting to a shared mode. Additionally, shared mobility could extend the catchment area of public transit, potentially playing a key role in bridging gaps in existing transportation networks and encouraging multi-modality by addressing first-and-last mile issues relating to public transit access. Finally, shared mobility could provide economic benefits, such as increased economic activity near multimodal hubs and cost savings to users. While many of the shared modes discussed in this white paper could address Caltrans' accessibility, livability, and economic goals for mobility in California, more research is needed—particularly on the city and regional level—and across the range of shared mobility strategies. While shared mobility holds promise for addressing a number of social and environmental goals, it is important to note that policy challenges remain in mainstreaming these services and ensuring public safety, adequate insurance, and fair labor practices, depending on the service model.

APPENDICES

Appendix A: Glossary of Terms

Term	Definition
Alternative Transit Services	Alternative transit services is a broad category that encompasses shuttles (shared vehicles that connect passengers to public transit or employment centers), paratransit, and private sector transit solutions commonly referred to as microtransit. Microtransit can include fixed route or flexible route services, as well as offer fixed schedules or on-demand service. In its most agile form (flexible routing, scheduling or both), microtransit and paratransit can be bundled under the category known as flexible transit services.
Bikesharing (e.g., Bay Area Bike Share, Citi Bike, Capital Bikeshare)	Users access bicycles on an as-needed basis for one-way (point-to-point) or roundtrip travel. Station-based bikesharing kiosks are typically unattended, concentrated in urban settings, and offer one-way station-based service (bicycles can be returned to any kiosk). Free-floating bikesharing offers users the ability to check-out a bicycle and return it to any location within a predefined geographic region. Bikesharing provides a variety of pickup and drop-off locations. The majority of bikesharing operators cover the costs of bicycle maintenance, storage, and parking. Generally, trips of less than 30 minutes are included within the membership fees. Users join the bikesharing organization on an annual, monthly, daily, or per-trip basis.
Carsharing	A program where individuals have temporary access to a vehicle without the costs and responsibilities of ownership. Individuals typically access vehicles by joining an organization that maintains a fleet of cars and light trucks deployed in lots located within neighborhoods, public transit stations, employment centers, and colleges/universities. Typically, the carsharing operator provides insurance, gasoline, parking, and maintenance. Generally, participants pay a fee each time they use a vehicle.
Closed-Campus Bikesharing (e.g., Social Bicycles, Zagster)	Closed-campus bikesharing systems are increasingly being deployed at university and office campuses. These closed-campus systems are available only to the particular campus community they serve.
Courier Network Services (CNS)	Courier Network Services provide for-hire delivery services for monetary compensation using an online application or platform (such as a website or smartphone app) to connect delivery drivers using a personal transportation mode with package/item or food delivery requests. These services can also be used to pair package delivery with passenger trips, where for hire-drivers can deliver both passengers and packages, either together or in separate trips.

E-Hail Apps (e.g., Curb, Flywheel, Hailo)	Smartphone apps that connect licensed taxi or pedicab drivers with passengers. Pedicabs are tricycles with passenger seating that can be hired for rides.
Employer Shuttles (e.g., Google, Facebook, Genentech)	Employer-sponsored shuttles that ferry employees between suburban workplaces and public transit stations.
Fixed Route and Fixed Schedule Microtransit (e.g., Chariot)	Fixed route and fixed schedule microtransit occurs where the routing and arrival/departure times of the shared vehicles are fixed. The alignment of routes, however, can be "crowdsourced" (i.e., users can request origin-destination points on a tech-enabled platform that can inform the operators of which routes to introduce). This type of microtransit most closely mirrors public transit.
Flexible Route and On-Demand Schedule Microtransit (e.g., Bridj, Via)	Users can request shared vans or buses real-time through a tech-enabled application, and the vehicle will deviate from its route to somewhere within walking distance from the requester. These services can range in how dynamic they are—from routes that change over the span of a few days to fully dynamic routes that adjust in real time based on traffic and demand.
Fractional Ownership (e.g., Audi Unite)	Carsharing where multiple individuals sublease or subscribe to a vehicle owned by a third party.
Gamification (e.g., Metropia, Waze)	The application of typical elements of game playing (e.g., point scoring, competition with others, rules of play) to trip planning, so as to incentivize more sustainable travel behavior and trip mode choices.
Hybrid Peer-to-Peer (P2P)-Traditional Model (e.g., eGo)	Individuals access vehicles or low-speed modes by joining an organization that maintains its own fleet, but it also includes *privately-owned* autos or low-speed modes. The vehicles are distributed throughout a network of locations. Expenditures, such as insurance, are typically provided by the organization during the access period for both roundtrip carsharing and P2P vehicles. Members access vehicles or other low-speed modes through a direct key or combination transfer from the owner or through operator installed technology enabling "unattended access."
Microtransit	A privately owned and operated shared transportation system that can have fixed routes and schedules, as well as flexible routes and on-demand scheduling. The vehicles generally include vans and buses.
Multi-Modal Trip Aggregators (e.g., Citymapper, Nimbler, RideScout)	Apps that offer a single platform for planning trips involving different modes including: public transit, taxi services, carsharing, on-demand ride services, ridesharing, bicycling, walking, and personal vehicles.
One-way Carsharing (e.g., car2go, DriveNow, BlueIndy)	Carsharing that enables members to pick up a vehicle at one location and drop it off at another. Also called a point-to-point carsharing system. One-way carsharing services can be station-based or free floating.

Paired On-Demand Passenger Ride and Courier Services (e.g., Sidecar Deliveries, UberEATS)	A CNS model in which package/item and food delivery trips can be conducted by for-hire ride services (e.g., TNCs or pedicabs) either in single purpose or mixed-purpose trips.
P2P Bikesharing (e.g., BitLock, Spinlister)	P2P bikesharing is a system where users can rent out their private bikes when not in use to others. Spinlister (previously known as Liquid) is one P2P bicycle sharing system in North America. Another company, Bitlock, sells keyless Bluetooth bicycle locks that can be used for personal use or for P2P sharing.
Peer-to-Peer (P2P) Carsharing (e.g., Flightcar, Getaround, RelayRides)	P2P carsharing can also be called a peer-to-peer access model. This model employs privately-owned vehicles or low-speed modes made temporarily available for shared use by an individual or members of a P2P carsharing company. Expenditures, such as insurance, are generally provided by the P2P organization during the access period. In exchange for providing the service, operators keep a portion of the usage fee. Members can access vehicles or low-speed modes through a direct key or combination transfer from the owner or through operator-installed technology that enables "unattended access."
P2P Delivery Services (e.g., Postmates, Roadie, DoorDash)	A CNS where anyone who signs up can use their private vehicle or bike to conduct a delivery.
Peer-to-Peer (P2P) Marketplace (e.g., Jolly Wheels, RentMyCar)	P2P marketplace enables direct exchanges among individuals via the Internet. Terms are generally decided among parties of a transaction and disputes are subject to private resolution.
Personal Vehicle Sharing (PVS)	The sharing of privately-owned vehicles where companies broker transactions among car owners and renters by providing the organizational resources needed to make the exchange possible (i.e., online platform, customer support, driver and motor vehicle safety certification, auto insurance, and technology).
Ridesharing: Carpooling and Vanpooling (Carma Carpooling, vRide, Zimride)	Ridesharing facilitates formal or informal shared rides among drivers and passengers with similar origin-destination pairings. Vanpooling consists of 7-15 passengers who share the cost of the van and operating expenses and may share the responsibility of driving.
Ridesourcing / TNCs (e.g., Lyft, Sidecar, Uber)	Ridesourcing services (also known as transportation network companies or TNCs) provide prearranged and on-demand transportation services for compensation, which connect drivers of personal vehicles with passengers. Smartphone applications are used for booking, ratings (for both drivers and passengers), and electronic payment. There are a variety of vehicle types that can be offered by these services including: sedans, sports utility vehicles, vehicles with carseats, wheelchair accessible vehicles, and vehicles where the driver can assist older or disabled passengers.

Ridesplitting (e.g., Lyft Line, UberPOOL)	A form of ridesourcing where riders with similar origins and destinations are matched to the same TNC driver and vehicle in real time, and the ride and costs are split among users.
Roundtrip Carsharing (e.g., City CarShare, Zipcar)	Carsharing that allows members hourly access to shared vehicles that must be returned to the same location from where they were picked up. Depending on the operator, users can choose from a variety of vehicles including: sedans, vans, sports utility vehicles, plug-in hybrid vehicles, and all-electric vehicles.
Scooter Sharing (e.g., Scoot Networks)	Users gain the benefits of a private scooter without the costs and responsibilities of ownership. Individuals typically access scooters by joining an organization that maintains a fleet of scooters at various locations. Typically, the scooter operator provides gasoline, parking, and maintenance. Generally, participants pay a fee each time they use a scooter. They can be roundtrip, one-way, or both.
Single Mode Trip Planning Apps (e.g., Embark iBART)	Trip planning apps that are designed for a single mode, such as a public transit system or driving.

Appendix B: Summary of Selected Microtransit Services

Microtransit			
Operator	**Category of Microtransit**	**Description**	**Cities**
Chariot	Fixed, Pre-Determined Routes and Fixed Schedules	A smartphone-enabled transportation service in which 15-seater vans run along fixed routes and can be located in real time with their smartphone app. New routes are "crowdsourced" based on demand. As of October 2015, Chariot operates seven fixed routes in San Francisco in AM and PM peak times only.	San Francisco
Bridj	Flexible Routes and On-Demand Scheduling	A smartphone-enabled transportation service that allows customers to request a ride to and from select neighborhoods in 14-seater vans. After receiving pickup requests, their algorithms determine a central optimal meeting spot for passengers.	Boston, Washington D.C.
Via	Flexible Routes and On-Demand Scheduling	A smartphone-enabled transportation service that operates van rides to passengers requesting pickups in real time based on similar origins and destinations. Riders may be asked to walk to an adjacent one-way avenue for operational efficiency. The service is fully dynamic, as it does not have any static routes or schedules and reroutes its vehicles based on traffic and demand in real time.	New York City

Appendix C: Summary of Selected Courier Network Services

The following services are categorized into two CNS models:

1) P2P Delivery Service
2) Paired On-Demand Passenger Ride and Courier Services.

Service Name	Category of CNS	Description	Operating Cities
Postmates	P2P Delivery Service	On-demand delivery service for groceries, take-out, and other goods	Atlanta, Austin, Boston, Charlotte, Chicago, Dallas, Denver, Houston, Las Vegas, Los Angeles, Miami, Minneapolis, Nashville, New York City, Orange County, Philadelphia, Phoenix, Portland, San Antonio, San Diego, San Francisco Bay Area, Seattle, Virginia Beach, and Washington, D.C.
Instacart	P2P Delivery Service and partly Dedicated Team of Employed Couriers	Grocery delivery service	Atlanta, Austin, Boston, Chicago, Denver, Los Angeles, New York City, Philadelphia, San Francisco Bay Area, Seattle, and Washington, D.C.
DoorDash	P2P Delivery Service	On-demand delivery service for restaurants	Boston, Chicago, Dallas, Houston, Minneapolis, New York City, Phoenix, San Francisco Bay Area, Southern California, and Washington, D.C.
Shipbird	P2P Delivery Service	P2P delivery service for packaged goods	San Francisco Bay Area
Roadie	P2P Delivery Service	P2P delivery service for packaged goods	All 50 states (primarily the South)
Sidecar Deliveries	Paired On-Demand Passenger Ride and Courier Services	On-demand delivery service for food, groceries, packages, and other goods	Boston, Charlotte, Chicago, Los Angeles, San Diego, San Francisco Bay Area, Seattle, and Washington, D.C.
UberEATS, UberCARGO, and UberRUSH	Paired On-Demand Passenger Ride and Courier Services	UberEATS is an on-demand meal delivery service. UberCARGO provides a van or larger vehicle and a driver to help the requester transport large items. UberRUSH is a courier service, either on bike, foot, or in the courier's personal vehicle.	Austin, Barcelona, Chicago, Los Angeles, New York City, San Francisco (also includes RUSH), Toronto, Washington, D.C., Hong Kong (CARGO)

Appendix D: Summary of Selected Trip-Planning Mobile Apps

Mobile App Name	Category of Trip Planning App	Functions	Year Launched
Embark iBART	Single Mode Trip Planning	Provides real-time arrival information for Bay Area Rapid Transit (BART) trains by station. Also provides information relating to delays and closures.	2012
Metropia	Single Mode Trip Planning and Gamification	Offers incentives for people to take alternative routes and depart at different times to reduce congestion along certain routes	2014
Waze	Single Mode Trip Planning and Gamification	Provides turn-by-turn route guidance for driving, with real-time traffic and accident information	2009
Citymapper	Multi-Modal Trip Aggregator	Similar to RideScout, integrates public transit, ridesharing, carsharing, personal vehicle driving, and bikesharing into route options	2011
Google Now	Multi-Modal Trip Aggregator	Helps with planning public transit or traffic trips, using Google's traffic and real-time public transit information, and it integrates it with the user's daily life	2014
Nimbler	Multi-Modal Trip Aggregator	Provides turn-by-turn directions, accounting for travel by bike, train, bus, and foot. The app accounts for real-time traffic and public transit delays when evaluating route options.	2012
RideScout	Multi-Modal Trip Aggregator	Provides route options that list different modes, approximate cost, calories burned, departure and arrival times, and trip duration	2013
Swyft	Multi-Modal Trip Aggregator	Uses real-time arrival and cost information to generate route options for users. Combines Muni, BART, Uber, and walking. Also allows users to input overcrowding and delay information to alert other Swyft users.	2015
TripGo	Multi-Modal Trip Aggregator	Allows the user to set their relative priorities among saving money, time, the environment, and convenience. It includes CO_2 calculations and integrates with user calendar.	2012

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