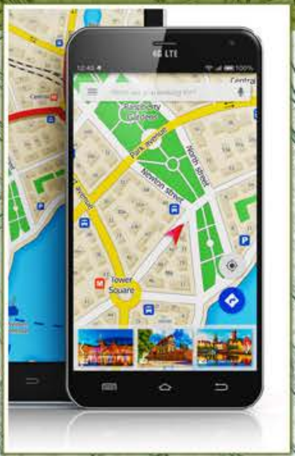
SMARTPHONE APPLICATIONS TO INFLUENCE TRAVEL CHOICES

PRACTICES AND POLICIES



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16. Abstract
This primer provides an overview of current practices in this emerging field and looks toward the future in the evolution and development of smartphone applications for the transportation sector. The primer provides an introduction and overview smartphone applications (known as "apps"); discusses the background, evolution, and development of smartphone apps; reviews the types of smartphone applications promoting transportation efficiency and congestion reduction; discusses transportation apps and their impacts on traveler behavior; examines current challenges; and concludes with guiding principles for public agencies.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
ºF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	ºC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

SI* (MODERN METRIC) CONVERSION FACTORS (CONTINUED)

APPROXIMATE CONVERSIONS FROM SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
ºC	Celsius	1.8C+32	Fahrenheit	ºF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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LIST OF TERMS

Gamification – the use of game design elements in a non-game context

Incentives – a payment or concession provided to a mobile app user to encourage app use, retention, or some other type of behavior

Mobility Consumer – a person who purchases and uses transportation for personal use

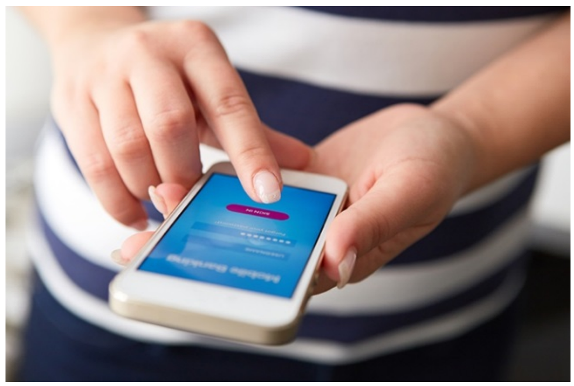
Smartphone App – a software application that runs on a mobile phone

Transportation App – a transportation-specific software application that runs on a mobile phone

CHAPTER 1. INTRODUCTION AND OVERVIEW

INTRODUCTION

Over the years, smartphone applications (apps) have evolved from early basic applications to multi-platform, advanced features that we commonly see today. Mobile and smartphone adoption is strikingly pervasive. A Pew Research study found that as of April 2015, 64% of American adults owned a smartphone. This study also found that 19% of American adults either do not have broadband access at home or have relatively few options for getting online other than their mobile devices (Smith, 2015).



Source: Thinkstock Photo

Demographic shifts, improvements in computing power and mapping technology, the use of cloud computing, changes in wireless communication, concerns about congestion, and increased awareness about the environment and climate change are changing the way people travel. Increasingly, mobility consumers are turning to smartphone "apps" for a wide array of transportation activities including: vehicle routing, real-time data on congestion, information regarding roadway incidents and construction, parking availability, and real-time transit arrival predictions. For example, according to that same Pew study, 74% of adults used their phones to get directions or other location-based services. Sixty-five percent of smartphone users indicated that they had received turn-by-turn navigation or directions while driving from their phones, and 15% did so regularly. As of April 2015, the study found that 25% of mobile phone users occasionally received real-time public transit information using their devices; 10% accessed public transit information from their devices regularly. The study also found that 11% of users occasionally and 4% frequently accessed a taxi or car service from their mobile devices. However, the study also found that 72% of smartphone owners have never used their devices to access a taxi or car service (Smith, 2015). Moreover, a travel survey conducted by Expedia with nearly 9,000 adults in 25 countries found that 35% of business travelers used their phones in booking transportation from one point to another (Schaal, 2014).

This high adoption rate should not come as a surprise. The increasing availability, capability, and affordability of intelligent transportation systems, global positioning system (GPS), wireless, and cloud technologies—coupled with the growth of data availability and data sharing—are causing people to increasingly use smartphone transportation apps to meet their mobility needs. Travel time savings (e.g., high occupancy vehicle lanes available to users of dynamic ridesharing); financial savings (e.g., dynamic pricing providing discounts for peak and off-peak travel and for choosing low-volume routes); incentives (e.g., offering points, discounts, or lotteries); and gamification (e.g., use of game design elements in a non-game context) are among the key factors driving end-user growth of smartphone transportation applications (Deterding *et al.*, 2011, Marczewski, 2012).

The same Pew study found that mobile users have significant concerns about their data privacy. More than half of app users decided not to install or uninstalled an app because of privacy concerns about their personal information, and 20% turned off location tracking (Smith, 2015). This study suggests increasing concerns by smartphone users about privacy.

This primer is intended to demonstrate how vital smartphones are becoming to the transportation network and provide public agencies, transportation managers, and elected officials with a perspective and understanding the role of smartphones in identifying services and choices for individuals and influencing travel behavior. The development of this primer was made possible by 13 specialists and practitioners that conducted an expert review of this primer and participated in a one-day workshop on July 1, 2015, at the US Department of Transportation Headquarters. The workshop brought together "thought leaders" from across North America to discuss smartphone apps and how to help public agencies develop supportive policies and programs. The document is organized into seven chapters.

In this first chapter, **Introduction and Overview**, the document presents the project background and an overview for the state-of-the-practice chapters.

Next, **Chapter 2, Background: Setting the Stage,** presents background information on the history and trends affecting the growth and evolution of mobile phones, smartphone applications, and associated technologies.

Chapter 3, Smartphone Application Types Promoting Transportation Efficiency and Congestion Reduction, presents four types of transportation apps that are in widespread use today:

- Mobility Apps: Apps that are mobility focused and include the following derivatives: business-to-consumer (B2C) sharing apps; mobility trackers; peer-to-peer (P2P) sharing apps; public transit apps; real-time information apps; ridesourcing or transportation network company (TNC) apps; taxi e-Hail apps; and trip aggregator apps.
- Vehicle Connectivity Apps: Apps that help users to connect to their vehicles remotely; these apps can be very beneficial in case of lockouts or an accident.
- Smart Parking Apps: Apps that make the parking process more efficient by highlighting the real-time availability and parking cost. Additionally, smart parking apps enable ease of payment. Valet parking apps allow the user to hire an experienced valet to park their vehicle after dropping it off at a convenient location.
- Courier Network Services (CNS) Apps: Apps that are focused on efficiently delivering goods to individuals.

Additionally, this chapter discusses three categories of non-transportation apps that deploy strategies that may be useful for future transportation apps. These three categories of apps may encourage active modes (e.g., cycling and walking), increase environmental awareness, and impact the ways in which people drive. These three categories include:

- Health Apps: Apps that assist users in monitoring their health (e.g., calories burned, heart rate, etc.); understanding the health impacts of their transportation choices; and encouraging health-conscious behavior, such as walking and biking. Outside of mobility, health apps are integrating health records, providing low-cost medical care, and creating motivational communities focused on health.
- Environment/Energy Consumption Apps: Apps that track environmental impacts and energy consumption of travel behavior, for example greenhouse gas (GHG) emissions associated with different modal choices. Outside of mobility, environment/energy apps are reducing material consumption, connecting consumers to the environment, and generating awareness of important environmental issues.
- Insurance Apps: Apps that enable users to opt for pay-per-mile automobile insurance (e.g., Metromile) and other usage-based pricing and incentives related to distance, time-of-travel, and safe driving (e.g., Allstate’s usage-based insurance app). Outside of mobility, insurance apps are speeding the insurance claims process and reducing insurance fraud.

Next, in **Chapter 4, Transportation Apps and Their Impact on Travel Behavior**, highlights the social and behavioral aspects impacting the success of these applications. This includes cognitive impacts; actual and perceived control; privacy safeguards; the role of trust; the reframing of norms and defaults in transportation choices; price, actual value, and perceived value; information availability; social pressure; risk analysis; and the delivery of incentives.

Chapter 5, Current Challenges aims to summarize challenges app developers and public agencies confront in this space.

In **Guiding Principles for Public Agencies and Policymakers (Chapter 6)**, some guidelines are outlined that can be adopted by public agencies as they investigate smartphone apps. Taking into account future trends in the design of smartphone apps and advances in transportation technology, this chapter highlights some best practices that can be implemented by policymakers and public agencies to maximize impact.

Through this structure, the document serves to inform future transportation policy and investment decisions by providing a holistic perspective on the state of smartphone app use among travelers.

CHAPTER 2. BACKGROUND: SETTING THE STAGE

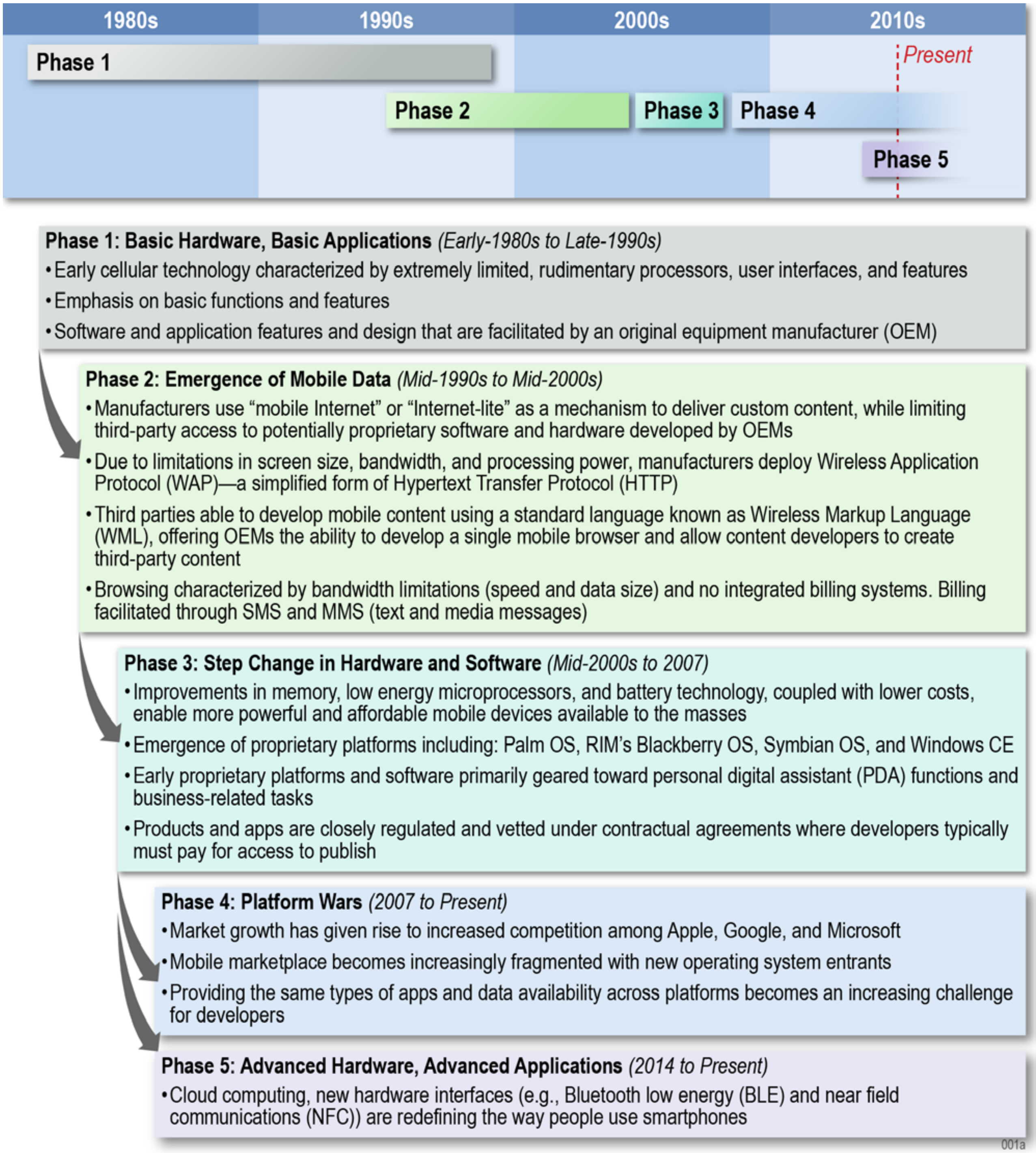
BACKGROUND AND EVOLUTION OF SMARTPHONE APPS

To understand how mobile technologies and smartphone applications are impacting how people travel, it is helpful to explore the history and trends leading to the growth of smartphones and mobility applications. This scan identifies five key phases in the evolution of smartphone apps: basic applications, wireless application protocol, the rise of proprietary platforms, platform wars, and the rise of multi-platform advanced features. These phases are summarized in Figure 1 on the following page.

Phase 1: Basic Hardware, Basic Applications: Early-1980s to Late-1990s

The first mobile applications trace their origin to the mid-1990s and were extremely limited by rudimentary processors and user interfaces that early generation mobile phones made available. The Motorola DynaTac 8000X was the first commercially available mobile phone. First marketed in 1983, it had talk time of about 30 minutes and retailed for approximately $4,000 (a new Ford Escort the same year retailed for approximately $5,200). The Motorola DynaTac made calls and included a simple contact application as part of the device's early software (Clark, 2012). This and other trailblazing applications focused on basic functions, such as arcade games, ring tone editors, calculators, and calendars. During this phase, software and application features and design were facilitated by the original equipment manufacturer. As the underlying computing hardware of mobile phones began to advance, new multi-functional applications began to emerge in which some took advantage of early developments in resistive touchscreen technology to deliver richer user experiences (e.g., Sony Ericsson P-series). These developments fundamentally changed the way owners viewed their phones: from a single-purpose calling device to a multi-purpose personal and business tool. Over time, consumers began to demand more features (Clark, 2012).

Source: Thinkstock Photo



Source: Transportation Sustainability Research Center, University of California Berkeley and Booz Allen Hamilton, December 2015

Figure 1. Five key phases in the evolution of smartphone apps

Phase 2: Emergence of Mobile Data: Mid-1990s to Mid-2000s

As time progressed, manufacturers began to turn to the Internet as a mechanism to deliver customized content while limiting third-party access to potentially proprietary software and hardware developed by the original equipment manufacturers. Because early mobile technologies were not directly compatible with the Internet due to limitations in screen size, bandwidth, and processing power, manufacturers developed the Wireless Application Protocol (WAP). WAP was a simplified form of hypertext transfer protocol (HTTP), and the foundation for the World Wide Web (Clark, 2012). WAP was designed to operate within the confines of cellular memory and limited bandwidth. Third parties could develop mobile content using a standard language, known as Wireless Markup Language (WML). For equipment manufacturers, WAP offered them the ability to develop a single mobile browser and allow content developers to create third-party content. However, the lack of direct interface with HTTP and limited user interfaces, often symptomatic of technological limitations, were common criticisms of WAP (Clark, 2012). Additionally, WAP browsers were slow and tedious, and there was no integrated billing system with WAP, and payments had to be awkwardly facilitated through either Short Message Services (SMS – known as text messages) or Multimedia Messaging Services (MMS – known as picture or multimedia messages). A poor user experience from technological constraints limited commercial viability. Users found it difficult to type on numeric keypads; small screens resulted in content that was hard to read; and users found it frustrating to load a sentence fragment and would then be forced to wait for the next data fragment to download.

Phase 3: Step Change in Hardware and Software: Mid-2000s to 2007

Improvements in memory, low-energy microprocessors, and battery technology coupled with lower costs enabled the creation of dramatically more powerful non-cellular mobile device hardware that could run more sophisticated operating software, such as Windows and Linux. Most of these were proprietary, "closed ecosystems" controlled by the handset maker and/or operating system developer. Desktop computer developers, which were previously non-participants in mobile development, had new devices for content development (Clark, 2012). During this phase, a variety of proprietary platforms emerged including Palm Operating System (OS), RIM's Blackberry OS, Symbian OS, and Windows CE. These early proprietary platforms were primarily geared toward personal digital assistant (PDA) functions and business-related tasks.

Mobile manufacturers began a marked shift in the late-1990s and early-2000s aimed at bridging the gap between business-use mobile computing and mobile phones. In 1996, Nokia launched its communicator series that was intended to serve as a mobile phone and computer simultaneously with a convertible clamshell design and fax, email, messaging, and web browsing capabilities. Similarly, Microsoft's Pocket PC (later renamed to Windows Mobile) was designed to mimic the user interface of Windows XP with a mobile start button and to bridge hardware gaps by operating on smartphones with touchscreens, mobile phones without touchscreens, and on PDAs with stylus functionality. These early hardware and software platforms laid the groundwork for today's smartphone technologies but were limited by hardware and data bandwidth capabilities.

Source: Thinkstock Photo

The 2007 launch of Apple's iPhone marked significant advancements in hardware and software capabilities, as well as the user experience. In addition to these advancements, the iPhone became the first mass marketed mobile device supporting third-party applications and cloud computing using a mobile Internet connection. Incorporating GPS (later coupled with GPS assist using cellular triangulation) enabled the iPhone to quickly lock onto GPS signals and be used for a variety of mobility functions, thereby changing not just how smartphones were used but also how people traveled. A key advancement with the iPhone was full website compatibility. Web sites no longer needed special mobile sites. Instead full web pages could be fully displayed on a mobile device. This was crucial in bringing a complete Internet experience to mobile devices and bridging the hardware and software digital divide that had severely curtailed the delivery of products and services to mobile Internet users. These advancements were followed by Google's Android and an updated version of Windows Mobile, dubbed the "Windows Phone."

With proprietary mobile platforms, developers and/or their products are closely regulated and vetted under contractual agreements. Under these proprietary mobile platforms, developers typically must pay for access to publish. This limits innovation, app availability, and compatibility across platforms.

Phase 4: Platform Wars: 2007 to Present

Increased competition has given rise to a new phase, known as "platform wars," marked predominantly by increased competition among Apple, Google, and Microsoft (Clark, 2012). As new entrants launch, the mobile marketplace becomes more fragmented. The provision of the same types of apps and data availability across platforms becomes an increasing challenge for developers. While this is rarely a problem for well-resourced companies that can develop application versions for multiple platforms, this represents a tiny selection of the huge universe of apps available. Lack of open-source standardization has created an increasingly complex marketplace where it is challenging for new market entrants (entrepreneurs and app developers) with limited resources to make their content available for all mobile users across a wide array of operating systems.

Phase 5: Advanced Hardware, Advanced Applications: 2014 to Present

Cloud computing and new hardware interfaces, such as Bluetooth Low Energy (BLE)[1] and near field communications (NFC)[2], are also redefining the way people use smartphones and offer a number of practical uses in transportation. In addition to BLE and NFC, a number of new trends are shaping what apps do and how users interact with them:

1. Wider, integrative use of data: Apps, like Google Maps, draw on disparate data feeds (traffic sensors, device GPS tracks, self-reported roadway incidents) to offer more tailored and accurate predictions of travel time to the user.

2. More data sharing among services: Apps like Google Now pull data from multiple sources and third-party apps to offer "at a glance" overviews of important information. For example, a user could draw from the map app to show the best trip routing in a calendar app .

3. Functional disaggregation: Apps are becoming less multi-functional and are instead focusing more on one or two key functions.

4. Bundled apps as services: As data flows freely and functionality becomes more dispersed, new aggregator services—either new apps or native functions of operating systems—are creating new services, or "cards," from assemblages of multiple apps. For example: a card notification on a smartphone informs the user of a new e-mail, next it allows the user to quickly respond (making use of the mail app), and it can add an event to the user's calendar (making use of the calendar app) or respond using an SMS (using the texting app)—all without opening a single dedicated app.

These trends are ultimately leading to more seamless, targeted, tailored and real-time services for the user. For example, the new App Extensions platform from Apple allows app developers to make app functionality available all over the device operating system: displaying information in new places, allowing sharing to new channels, adopting common data stores and more. Other app developers are already embedding other apps of their own (e.g., Twitter cards support payments using functionality borrowed from the Stripe mobile payments app). Transportation apps are also experiencing changes: Uber ridesourcing vehicles can be hailed from inside Google Maps, and delivery services are being embedded in restaurant apps. In the future, we can expect that the basic activity of getting ride options

[1] *Bluetooth Low Energy (BLE):* With BLE, wireless transmitters known as BLE beacons (approximately the size of a matchbox with a coverage radius measured in feet) transmit Bluetooth signals to smartphones and other Bluetooth-enabled mobile devices. BLE communicates with many users, allowing people to be notified of coupons, offers, and promotional information when entering the Bluetooth range. For example, a user walking past a bikesharing kiosk, public transit station, or a bus stop could be notified of bicycle availability, special rates, or the departure time of the next public transit vehicle. BLE also supports beacon-based navigation, which can assist in guiding users to destinations. San Francisco International Airport is using BLE-beacon technology to assist the visually impaired in navigating its terminals. BLE does support mobile payment (Mogg, 2014).

[2] *Near Field Communications (NFC):* With NFC, smartphones communicate with postage-stamp sized NFC tags. NFC has a range of inches and communicates with a single user. NFC is best suited for settings requiring one-on-one secure data delivery. NFC can be used for mobile payment, transportation passes, and access cards (such as accessing a carsharing vehicle).

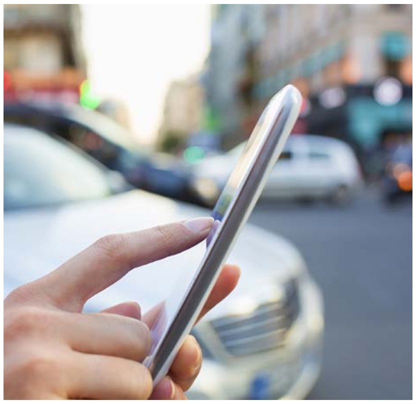
to a desired destination may call on multiple separate apps (mapping, scheduling, ride providers, social media, and more) to deliver the ideal suggestion, yet seamlessly so that the user is not burdened by the underlying inter-app collaborations required.

SUMMARY

In recent years, there has been a number of hardware and software developments contributing to the growth of smartphone transportation apps. In the next chapter, the scan reviews these types of apps in greater detail. Subsequent chapters review the behavioral and economic impacts of these applications; opportunities (e.g., planning and data collection) and challenges (e.g., privacy and digital divide); and best practices for deploying them.

CHAPTER 3. SMARTPHONE APPLICATION TYPES PROMOTING TRANSPORTATION EFFICIENCY AND CONGESTION REDUCTION

Smartphone apps are transforming mobility by improving access to transportation services, increasing mobility, and enhancing traveler engagement. These apps are spawning new businesses, services, and mobility models. For example, within a short period, app-based innovations leapfrogged the livery industry with services, such as Uber, Lyft, and Flywheel. Using smartphones to facilitate mobility is becoming the new norm. Smartphone apps have transformed the way that many travelers arrange for-hire vehicle services, plan for trips, or get real-time transportation information. This chapter includes a brief summary of existing smartphone application types, their features, and business models. It also provides a scan of transportation-related smartphone apps.



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TYPES OF APPS IMPACTING TRANSPORTATION

There are four broad categories of apps impacting transportation. These categories are delineated by the apps' primary function. The categories are: 1) mobility apps; 2) vehicle connectivity apps; 3) smart parking apps; and 4) courier network services (CNS) apps. For the non-mobility apps, the focus in this chapter is on their features that could impact mobility either now, such as by including information on the energy and health implications of transportation choices, or in the future as a result of demonstrating features that could be deployed in forthcoming mobility apps.

Mobility Apps

Mobility Apps are apps with a primary function to assist users in planning or understanding their transportation choices and may enhance access to alternative modes (Jones, 2013). While mobility apps may influence the user's health, energy use and environmental impacts, or the total cost for transportation, these impacts are generally not recorded or stated.

The mobility app marketplace is both broad and deep. Accordingly, the primer further categorizes mobility apps into eight sub-categories.

The eight sub-categories are:

1. ***Business-to-Consumer (B2C) Sharing Apps*** **are** apps that sell the use of shared transportation vehicles from a business to an individual consumer, including one-way and roundtrip trip carsharing (e.g., Zipcar).

2. ***Mobility Trackers*** are apps that track the speed, heading, and elapsed travel time of a traveler. These apps often include both wayfinding and fitness functions that are colored by metrics, such as caloric consumption while walking (e.g., GPS Tracker Pro).

3. ***Peer-to-Peer (P2P) Sharing Apps*** are apps that enable private owners of transportation vehicles to share them peer-to-peer, generally for a fee (e.g., Spinlister).

4. ***Public Transit Apps*** are apps that enable the user to search public transit routes, schedules, near-term arrival predictions, and connections. These apps may also include a ticketing feature, thereby providing the traveler with easier booking and payment for public transit services (e.g., Washington, DC’s Metrorail and Metrobus).

5. ***Real-Time Information Apps*** are apps that display real-time travel information across multiple modes including current traffic data, public transit wait times, and bikesharing and parking availability (e.g., Snarl).

6. ***Ridesourcing/TNC Apps*** are apps that provide a platform for sourcing rides. This category is expansive in its definition so as to include “ridesplitting” services in which fares and rides are split among multiple strangers who are traveling in the same direction (e.g., UberPOOL and Lyft Line).

7. ***Taxi e-Hail Apps*** are apps that supplement street hails by allowing location-aware, on-demand hailing of regulated city taxicabs (e.g., Flywheel).

8. ***Trip Aggregator Apps*** are apps that route users by considering multiple modes of transportation and providing the user with travel times, connection information, and distance and trip cost (e.g., Transit App).

Vehicle Connectivity Apps

Vehicle connectivity apps are apps that allow remote access to a vehicle through an integrated electronic system that can be used in times of emergencies (e.g., locked out of a car, asking for help when in an accident, etc.). The vehicle connectivity apps are generally developed by auto manufacturers (e.g., General Motor's OnStar).

Smart Parking Apps

Smart parking apps provide information on parking cost, availability, and payment channels. These apps are often paired with smart parking systems (e.g., SFpark). These apps can be grouped as follows:

1. *e-Parking* is used broadly to describe the integration of technologies to streamline the parking process—from real-time information on space availability to simplified payment methods (Shaheen & Kemmerer, 2008). e-Parking apps provide important information regarding real-time parking cost and availability (e.g., Park Whiz) and accessible payment channels for parking (e.g., Parkmobile).

2. *e-Valet* is used broadly to describe a for-hire parking service where drivers use an app to dispatch valet drivers to pick-up, park, and return vehicles. In addition to parking, some of these services also offer fueling, cleaning, and other vehicle services. *Valet Parking Apps* provide the ease of on-demand valet parking with flexible drop off and return locations (e.g., Luxe).

Courier Network Services (CNS) Apps

Courier Network Services (CNSs) (also referred to as flexible goods delivery) are apps that 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). These apps can be sub-divided into two types:

1. *Peer-to-Peer (P2P) Delivery Services* are apps that enable private drivers to collect a fee for delivering cargo using their private automobiles (e.g., Roadie).

2. *Paired On-Demand Courier Services* are apps that allow for-hire ride services to also conduct package deliveries (e.g., UberEATS).

NON-TRANSPORTATION APPS DEPLOYING STRATEGIES THAT MAY BE USEFUL FOR TRANSPORTATION APPS

Additionally, three categories of non-transportation apps that deploy strategies that may be useful for future transportation apps include: 1) Health Apps; 2) Environmental / Energy Consumption Apps; and 3) Insurance Apps.

Health Apps

Health apps are apps that assist users with monitoring their health (e.g., calories burned, heart rate, etc.) and changing their behavior (e.g., exercising more and eating less), as well as understanding the health impacts of their transportation choices. Outside of mobility, health apps integrate health records, provide low-cost medical care, and create motivational communities to support good health (e.g., Map My Walk).

Environment / Energy Consumption Apps

Environment / Energy Consumption Apps are apps that track environmental impacts and the energy consumption of travel behavior. For example, these apps might predict the Greenhouse gas (GHG) emissions associated with different modal choices (e.g., Refill). This category also includes eco-driving/eco-routing apps that encourage environmentally conscious driving by providing real-time feedback on driving behavior as related to energy use, efficient routing information, or both. The category also includes apps that help locate car charging stations for electric cars (e.g., greenMeter). Outside of mobility, environment/energy apps are motivating users to reduce their material consumption and carbon footprint, along with raising environmental awareness.

Insurance Apps

Insurance apps generally aim to tie a traveler's behavior, especially as a driver, to an individual's insurance premiums and user experience. These apps enable users to opt for pay-per-mile automobile insurance (e.g., Metromile) and other usage-based pricing and incentives, related to distance, time-of-travel, and safe driving (e.g., Allstate's usage-based insurance app). Outside of mobility, insurance apps are speeding the insurance claims process and reducing insurance fraud.

SMARTPHONE APP CHARACTERISTICS

To complete this scan, the Transportation Sustainability Research Center (TSRC) at the University of California, Berkeley conducted a smartphone services and mobility literature review and Internet search.

TSRC did not review mobile operating systems that were not mainstream in the U.S. marketplace. As a corollary, operating systems specific to the Asian and European markets and apps that are not available in English were excluded from this analysis.

Additionally, public transit agency apps were omitted from this analysis. Many of these apps are not available on the app marketplace but instead are available for download directly from the public transit agency's website. As such, an accurate census of these apps is difficult to obtain due to the vast number of public transit agencies nationwide.

However, where applicable, this literature scan references data from a Transportation Research Cooperative (TCRP) Synthesis 91, titled "*Use and Deployment of Mobile Device Technology for Real-Time Transit Information*" (Schweiger, 2011). While this synthesis report included a review of the websites of 276 U.S. transit agency members of the American Public Transportation Association (APTA), a similar methodology is not possible today. At the time of their survey, the open data standard commonly known as General (formerly Google) Transit Feed Specification (GTFS) had recently been developed and was not in widespread use. Since the development of GTFS open data, there has been a proliferation of innumerable public transit apps developed by third parties offering a variety of timetable, trip planning, and real-time app-based services.

Broadly speaking, the review covers two different scopes of apps. First, it covers the qualitative aspects and range of functionality across the entire universe of apps. Second, researchers completed a quantitative analysis of the more limited universe of apps with more than 10,000 total downloads.

In the entire universe of apps, the scan includes notable developments and new applications to account for recent innovations that may not have been available in the marketplace long enough to achieve a significant number of downloads. The findings of app cataloging are included, as appropriate.

In this more limited universe, the primer catalogs key data points available from the app marketplaces including operating system(s), geographic availability, business model, real-time information availability, gamification, and incentives. Eighty-three transportation-related smartphone applications across all four marketplaces, with more than 10,000 total downloads, were successfully identified. Applications with fewer total downloads were excluded from this analysis to focus on those in more widespread use.

The quantitatively surveyed smartphone apps can be categorized and characterized across six dimensions: operating system, geographic availability, business model, real-time information availability, gamification, and incentives. The apps within the high-download universe are characterized along these axes below.

Operating Systems

A review of applications by operating system found that the majority of transportation-related applications were only available on Android and iOS and thus were generally unavailable on Windows and Blackberry. Only 36% and 23% of transportation applications were available on Windows and Blackberry, respectively, compared to 86% and 80% availability on Android and iOS (TSRC, unpublished data, 2015). This suggests potential gaps in transportation app service availability on second-tier and emerging operating systems. A recent study of U.S. smartphone users by comScore found that as of January 2015, Android was the largest mobile OS with 53.2% of the market share, followed by Apple iOS with 41.3%. Microsoft, BlackBerry, and Symbian each had 3.6%, 1.8%, and 0.1% market share, respectively (Soomro, 2015). Thus, while the transportation apps are relatively unavailable on the Windows and Blackberry operating systems, the smaller market shares of these operating systems result in fewer users who are impacted by this gap. In turn, that low availability on those OSs may not significantly impact the transportation system.

Geographic Availability

Of the 83 transportation-related smartphone applications identified, 81 apps (98%) were available in North America, while 59 (71%) apps were obtainable in Europe (meaning that there is a fair amount of overlap). Fifty-three (64%) and 52 apps (63%) were available in Asia and Oceania (Australia/New Zealand), respectively. Sixty-two apps (75%) were available in developing regions of the world, including Africa, South America, and the Middle East. Smartphone applications not available in the U.S. were not assessed, and thus this review may overstate the regional availability of transportation-related applications in North America compared to other regions due to a sampling bias.

App Business Models

Independent and corporate application developers generally make their apps available in stores for users to download and install. Generally, a number of barriers exist within these closed-platform marketplaces. For example, most app stores only permit the sale and distribution of "approved" applications, and most stores also require developers to pay an annual subscription fee to submit apps and maintain their availability on a marketplace. In addition to downloading apps directly from a marketplace, a few app stores and mobile carriers permit the dissemination of an app through a hyperlink distributed through a web browser, text message, or multimedia message. Additionally, although their market share is negligible, a few mobile phone manufacturers have created their own app stores to market and sell third-party applications.

Not surprisingly, 93% of the transportation apps identified were offered free of charge (n=76/82). Seven percent of the transportation apps were only offered for purchase (n=6/82), and 17% offered a freemium version that has degraded features and/or the presence of advertising in contrast to the paid version (n=14/82). Freemium apps are free to download but also include in-app purchases for premium content, features, or the removal of advertising.

Boiling down this survey, the transportation apps can be classified into one of five common business models (Manoogian III, 2012). These include:

- Sale of an app on an app marketplace;
- Offering a free to download, periodic sale/subscription to use/update app (e.g., SaaS (software as a service), news services);
- Offering a free app, with in-app purchase features or the close variant 'freemium' model;
- Offering a free app supported through advertising; and
- Offering a free app that provides access to paid services (e.g., Uber).

In the "freemium" model, an app developer offers an app free of charge but charges for premium features. For example, the premium version may have fewer or no advertisements. This model is becoming increasingly popular (Findlay Schenck, 2011). App marketplaces may prefer paid apps because they charge the app developers a commission on app fees while they do not receive any revenue from in-app advertising (Flynn, 2010). For example, Apple receives a 30% commission on apps sold in its marketplace (Flynn, 2010). App marketplaces do not make revenue from any advertising clicks unless the app uses an advertising platform that is also owned by the marketplace owner (i.e., Apple, Google, and Microsoft) (Flynn, 2010). Apps may also generate additional revenue by selling user data to third parties and individual transactions (e.g., Uber, Lyft, and Flywheel).

Generally, advertisers are more willing to pay for ad impressions than users are willing to pay for applications without advertising. A study by Cambridge University found that 73% of the apps on Android's GooglePlay store were free of which 80% relied upon advertising revenue (Lunden, 2012). The study also found that only 20% of paid apps are downloaded more than 100 times (Lunden, 2012). Finally, the study found only 0.2% of paid apps are downloaded more than 10,000 times compared to 20% of free apps (Lunden, 2012). The Interactive Advertising Bureau estimated that mobile advertising revenue hit $19.3 billion in 2013, representing a 92% increase over the previous year (Interactive Advertising Bureau, 2014).

Real-Time Information Availability

The dispensing of real-time transportation data to smartphone users immediately after collection is the most important aspect of smartphone transportation apps supporting active travel demand management (ATDM). The availability of real-time information, such as traffic conditions, roadway incidents, parking availability, and public transit wait times, distinguishes newer apps from many early smartphone app services, such as those just providing static public transit timetables. Seventy-one percent of the transportation apps identified incorporated some type of real-time information into the application. The TCRP study of public transit data and apps found that 16% of APTA member agencies (45 of 276) provide some information on mobile devices with approximately 5% (15 of 276) providing real-time information (Schweiger, 2011). That number is sure to be much higher today.

Source: Thinkstock Photo

Gamification and Incentives

Gamification is the use of game theory and game mechanics in the mobile app context to engage smartphone users to employ an app in a particular way (Herger, 2015; Marczewski, 2012). Apps using gamification structure the end user as a "player" within the gamified app design. The use of leaderboards, badges, levels, progress bars, and points are examples of gamified applications meant to encourage and/or discourage particular user behaviors (Herger, 2015) (Marczewski, 2012). For example, a user might receive points, increased rankings, or rewards for environmentally-conscious behaviors, such as carpooling or riding public transit instead of driving alone or using an alternative mode on a "spare-the-air" day. By employing these techniques, gamification uses the social aspects of competition, achievement, and status to encourage players to compete within an app. A 2011 survey of Global 2000 companies found that 70% of companies planned to use gamification as a marketing and customer retention strategy (Van Grove, 2011). As such, gamification represents one potential strategy for encouraging positive transportation behaviors in the mobility context.

Twenty-three percent of the transportation apps identified for this scan incorporated some form of gamified incentive, such as savings, raffles, or favicons (a special badge denoting a level of achievement (n=19/81). Loyalty points that could be cashed in for various rewards were the most common incentive representing approximately one-fifth (21%) of all incentives (n=4/19).

Gamification is also often closely associated and paired with "incentives." Mobile app incentives often involve the user being incentivized to give up something to get something else (Dabbs, 2013). App developers commonly recognize two drop-off periods in engagement/use: 1) from install to first use and 2) first to second use. As such, app incentives commonly target these two periods (Dabbs, 2013).

For transportation, the goal is to get users to switch their behaviors repeatedly, thereby precipitating a long-term impact on the transportation network. Thus, app-based incentives in a transportation context might mean giving up the convenience or privacy of driving alone but being rewarded to ride in a high occupancy vehicle lane that reduces travel time. It may mean riding public transit to work more frequently, which can be perceived as less convenient, in exchange for a transportation demand management subsidy or rider incentive. Rider incentives for ongoing behaviors can include discounts, coupons, gift cards, and other rewards.

With mobile applications, there are in essence two types of incentives: 1) incentives to download the app and 2) incentives to use the app (or more specifically, gamified incentives that encourage or discourage a particular type of application use or behavior that is tracked by the application).

Restrictions against incentives to download an app are designed to maintain the integrity of app download ratings and discourage the practice of encouraging a high number of incentivized app downloads that in turn artificially raises the download count and increases an app's download ranking within an app marketplace. In July 2014, Apple began issuing rejection notices to app developers that offered incentives to users who post feedback about an app on social media (Bolluyt, 2014). Finally, as with all apps, continued customer engagement and retention are challenges following the collection of the incentive.

MOBILITY APPS

This section provides an example of each of the apps that impact transportation (mobility, parking, health, environment and energy, and insurance) identified in Section 3.1. Mobility apps are further broken down into the sub-categories, also noted in Section 3.1. The app examples are provided for illustrative purposes and do not represent an endorsement by the report authors or any other party involved in the development of the primer document.

Business-to-Consumer Sharing Apps

Zipcar (Figure 2) is an example of a Business-to-Consumer (B2C) carsharing service, which provides users short-term access to a fleet of cars owned by the business and not by individuals. **Zipcar** rentals are usually available in places like city centers, and they can be accessed by the hour or for the whole day. Fuel and insurance are also included, making it easier for the customer to use it instantly without owning a car. Zipcar operates in more than 150 U.S. cities and is also available in Austria, Canada, France, Spain, the UK, and Turkey. Other B2C apps in this space include **City CarShare** and **Enterprise CarShare** (both roundtrip carsharing); **car2go** and ReachNow (formerly DriveNow**)** (both one-way carsharing services); **Scoot Networks** (Scooter Sharing); and **Bridj** and **Via** (both microstransit services).

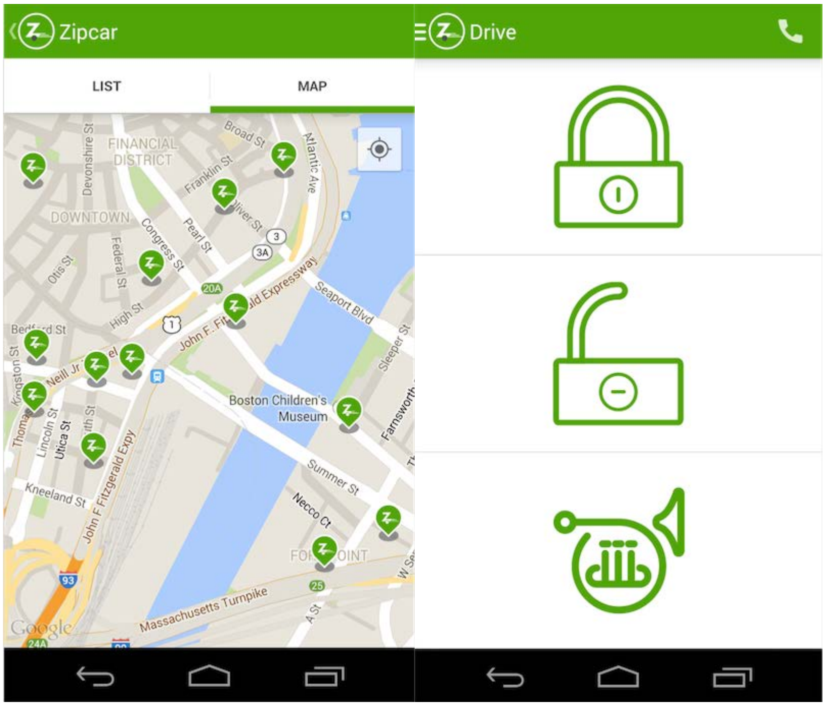

Figure 2. Screenshot depicts available Zipcar locations in San Francisco. Source: Google Play Store

Mobility Tracker Apps

GPS Tracker Pro (Figure 3) is an example of a mobility app that allows users to find and track friends and get directions to their location. The app also allows users to track their own mobile phone, if the device is lost or stolen. Other apps in this space include: **EmergenSee, Friend Locator: Phone Tracker**, and **GPS Phone Tracker Pro**.

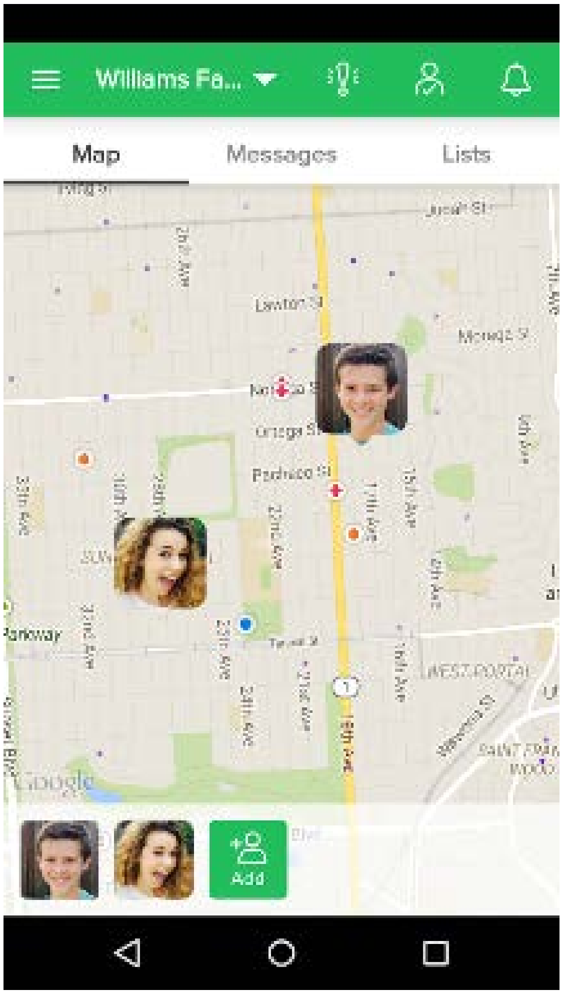

Figure 3. Screenshot of the GPS Tracker Pro mobility app. Source: Google Play Store

Peer-to-Peer Sharing Apps

Spinlister (Figure 4) is an example of a peer-to-peer bikesharing service provider offering users short-term access to a fleet of privately-owned bicycles. The **Spinlister** app enables bicycle owners to list bikes for rent and users to locate available bikes for reservation and access using the smartphone application. As of June 2015, **Spinlister** was available in Amsterdam, Austin, Boston, Chicago, Denver, London, Los Angeles, Miami, New York City, Portland, San Francisco, and the Seattle metropolitan areas. Other apps in this space include: **BitLock** (Peer-to-Peer bikesharing) and **FlightCar**, **Getaround**, and **Turo** (formerly known as RelayRides) (all Peer-to-Peer Carsharing operators).

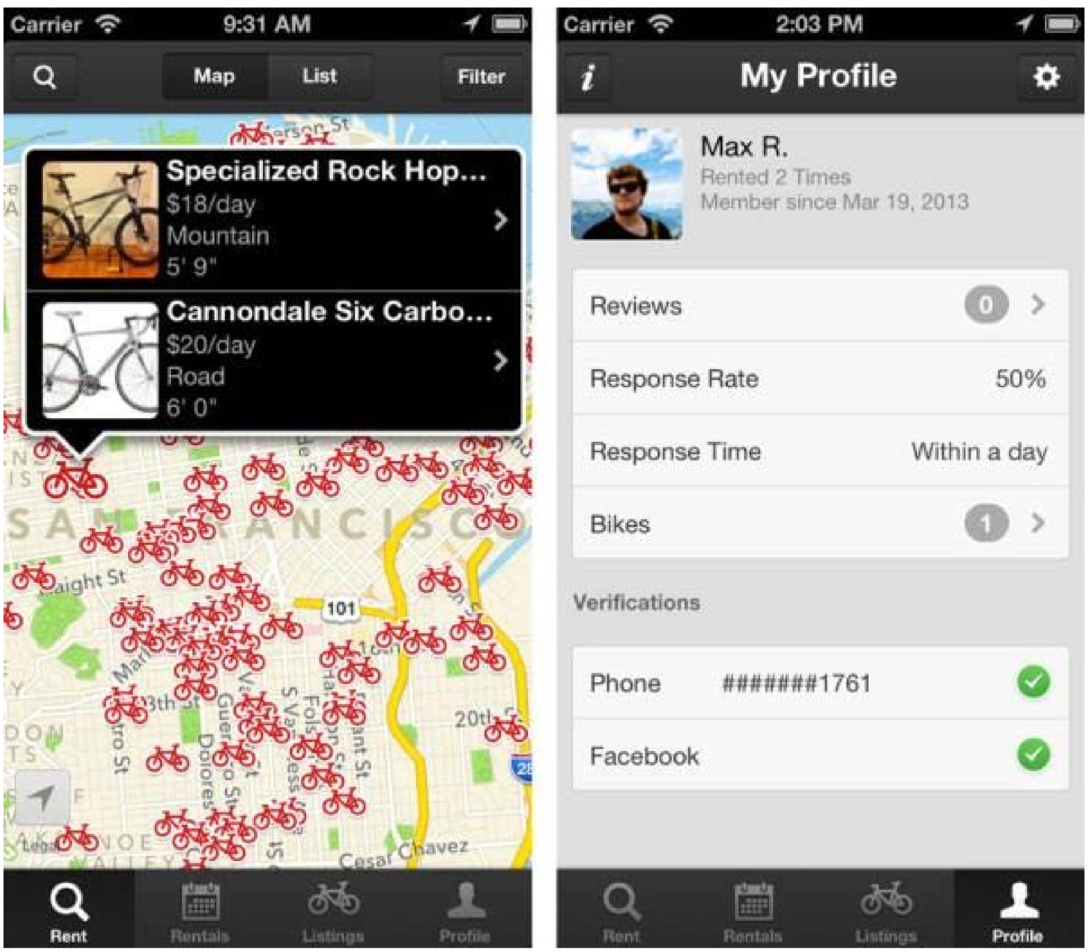

Figure 4. Screenshot depicting Spinlister peer-to-peer bicycle listings. Source: Google Play Store

Public Transit Apps

The **MuniMobile** public transit application (Figure 5) provides app-based fare payment and ticketing for the San Francisco Municipal Transportation Agency (commonly referred to as Muni). The app allows users to purchase and use fares and passes instantly on a smartphone without paper tickets. Other apps in this space include: **D.C. Metrorail and Metrobus**; **MyTransit NYC Maps & Schedules**; and **New York MTA Subway Map (NYC)**.

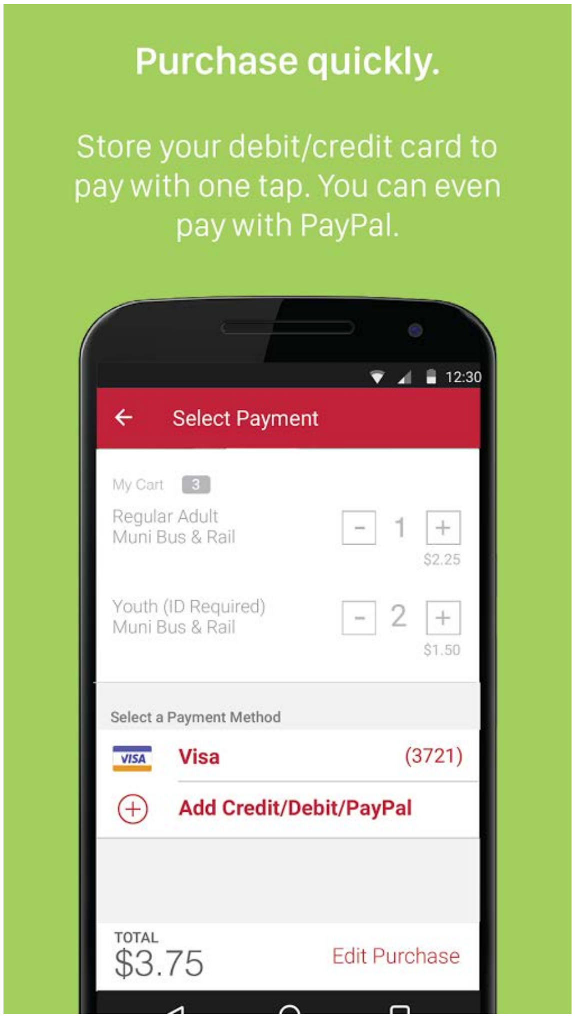

Figure 5. MuniMobile app screenshots showing the user interface and mobile fare payment. Source: Google Play Store

Real-Time Information Apps

Snarl (Figure 6) is an example of a real-time information app for Australian drivers. The Snarl app provides free traffic and roadway incident updates and displays real-time traffic information and traffic hot spots. Additionally, the app features a driving mode enabling drivers to dynamically navigate around traffic and roadway incidents. Other apps in this space include: **511 Transit; Commute: Live Traffic Alerts**; and **Florida 511**.

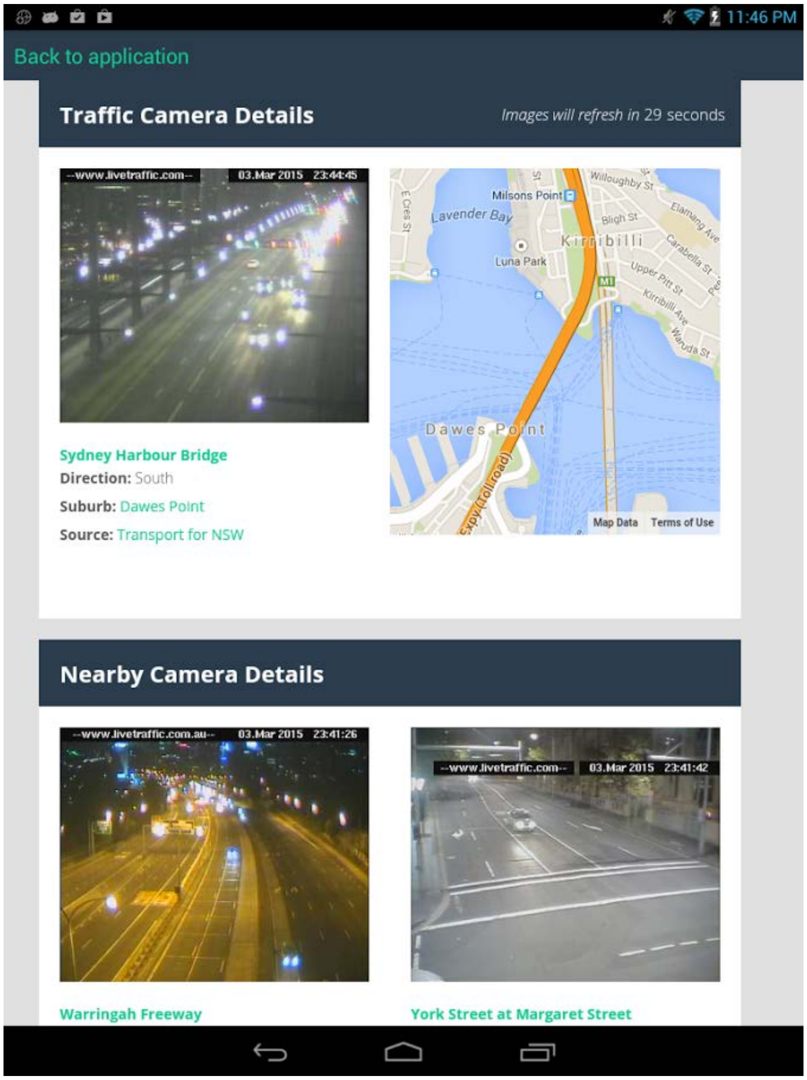

Figure 6. Screenshot of the Snarl app. Source: Google Play Store

Ridesourcing Apps

Lyft (Figure 7) is an example of a transportation network company application offering on-demand real-time for-hire vehicle services. The app uses an online platform to connect passengers with drivers using their personal vehicles for compensation. As of December 2015, **Lyft** was available in 31 states and the District of Columbia. Other apps in this space include **HopSkipDrive** and **Uber**.

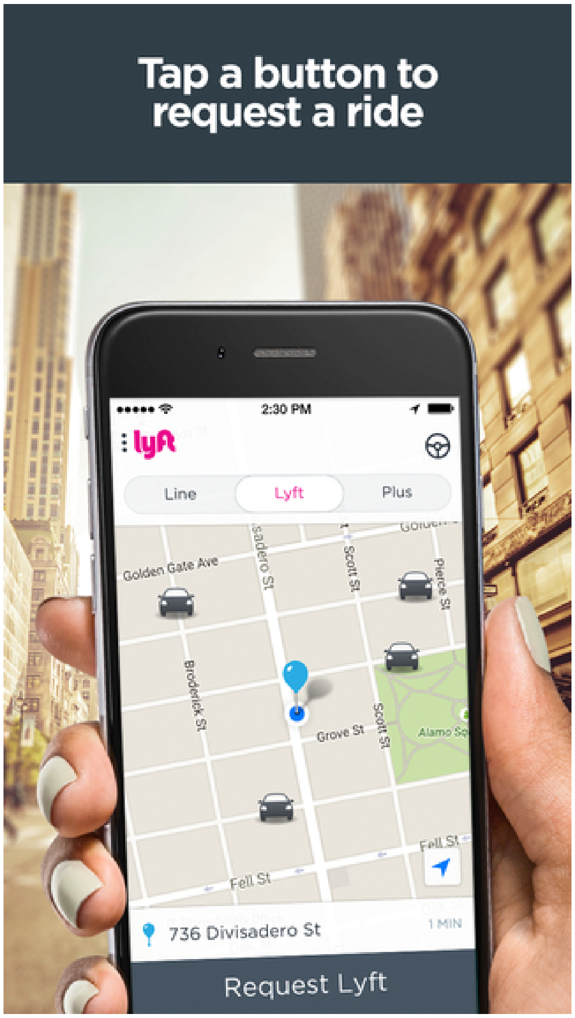

Figure 7. Screenshot of the Lyft app. Source: Google Play Store

Taxi e-Hail Apps

Flywheel (Figure 8) is an example of a mobile application for the taxi industry that connects passengers with taxi drivers. **Flywheel** enables passengers to e-Hail taxi drivers real-time, track taxi arrival via GPS, and pay their taxi fares from their smartphones. As of June 2015, **Flywheel** was available in the Los Angeles, Sacramento, San Diego, San Francisco, and the Seattle metropolitan regions. Other apps in this space include: **AeroTaxi, Bandwagon, Easy Taxi, Gett, Hailo,** and **mytaxi**.

Figure 8. Screenshots of the Flywheel e-Hail taxi app. Source: Mashable.com

Trip Aggregator Apps

The "**Swiftly App**" (Figure 9) is an example of an all-in-one multi-modal aggregator displaying public transit options, timetables, and real-time arrival and departure information (in select regions). Additionally, the app can display shared mobility information for more than 90 metropolitan regions in seven countries on three continents. Other apps in this space include: **GoLa** (Xerox) and Transit App.

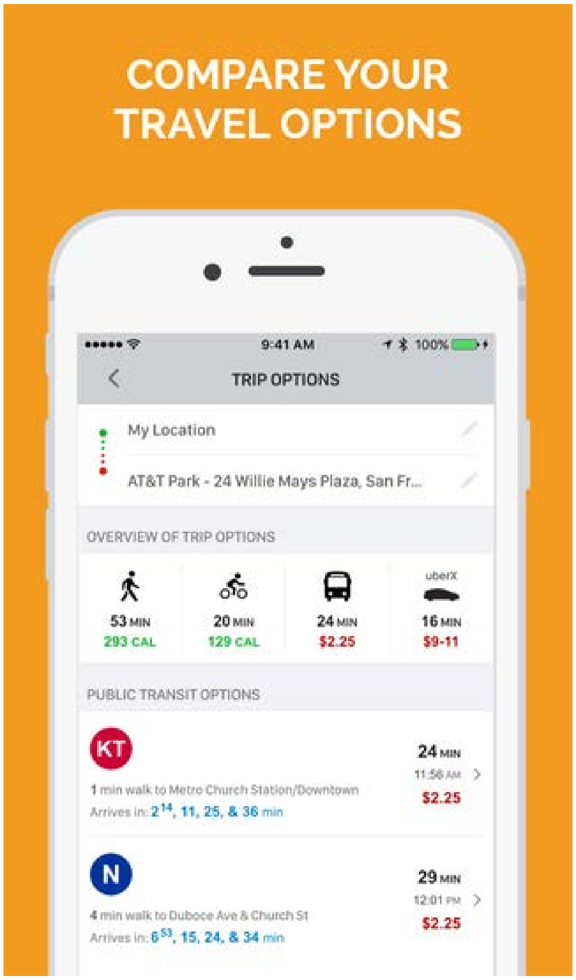

Figure 9. Screenshots from "Swiftly" app. Source: Swiftly

VEHICLE CONNECTIVITY APPS

OnStar (Figure 10) is a vehicle connectivity app by the General Motors group that provides subscription-based communications, in-vehicle security, hands-free calling, turn-by-turn navigation, and remote diagnostics systems. It provides emergency services like “Automatic Crash Response,” “Crisis Assist,” and “Roadside Assistance.” Additionally, it has sophisticated security features, such as “Stolen Vehicle Assistance,” including “Remote Ignition Block” and “Stolen Vehicle Slowdown.” Other apps in this space include: **Lexus Enform App Suite, M-B mbrace,** and **My BMW Remote**.

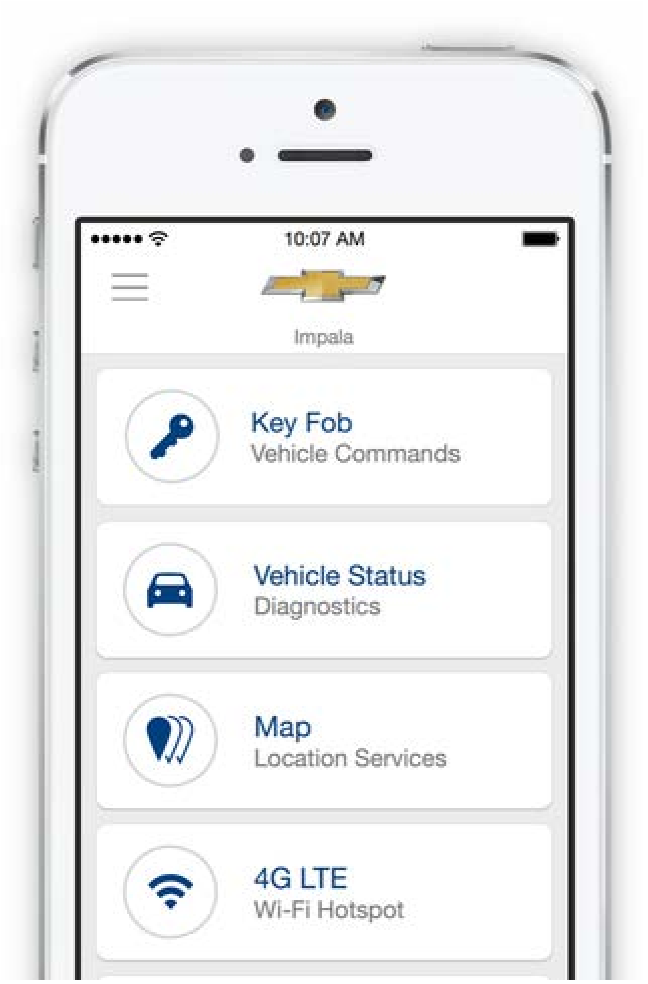

Figure 10. Screenshot of GM’s OnStar app. Source: Apple iTunes Store

SMART PARKING APPS

The **ParkWhiz** app (Figure 11) is an example of an e-parking app that allows drivers to search for available parking, view pricing, and make reservations at over 2,000 parking lots across the United States. Additionally, **ParkWhiz** customers are offered a discount for booking parking in advance. Other apps in this space include: **Best Parking, ParkMe,** and **SpotHero**.

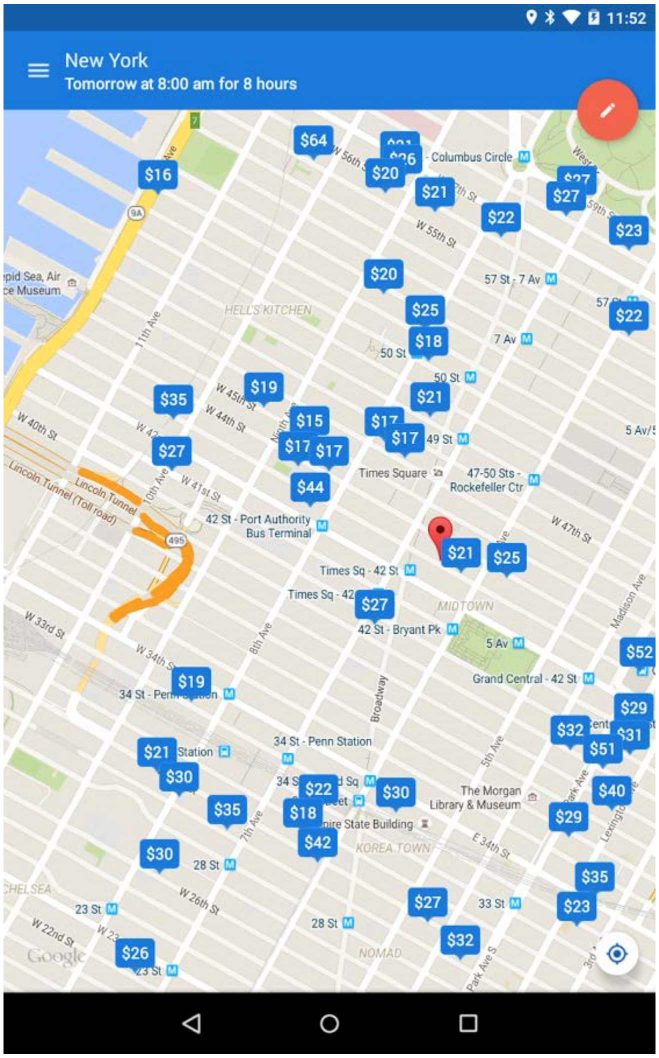

Figure 11. Screenshots of the ParkWhiz app. Source: Google Play Store

Luxe (Figure 12) is an example of an eValet parking app where car owners can hire experienced valets to park their car. There is the added flexibility of selecting different drop-off and return locations; some additional services offered by **Luxe** valets are washing and fueling of the car. As of October 2015, **Luxe** was available in nine U.S. cities: San Francisco, Los Angeles, Chicago, Seattle, Boston, Austin, New York, Philadelphia, and Washington D.C. Other apps in this space include: **1-2 Car Valet Services** and **Valet**.

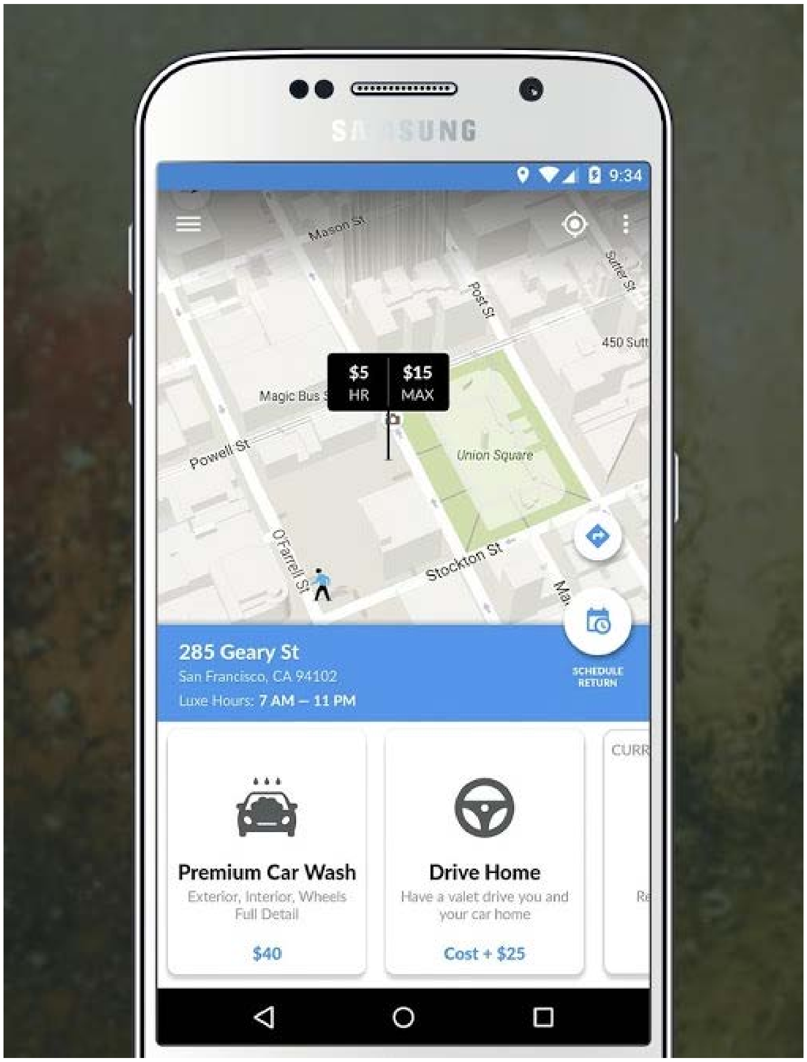

Figure 12. Screenshot of Luxe app. Source: Google Play Store

COURIER NETWORK SERVICES APPS

Roadie (Figure 13) is an example of a cargo delivery app permitting peer-to-peer delivery. Similar to ridesourcing, **Roadie** offers on-demand, real-time for-hire cargo services. The app uses an online platform to connect shippers with independent delivery drivers using their personal vehicles for compensation. As of March 2015, Roadie was available in all 50 states (Roadie, 2015). Other apps in this space include: **DoorDash, Postmates, Shipbird, and Shyp**.

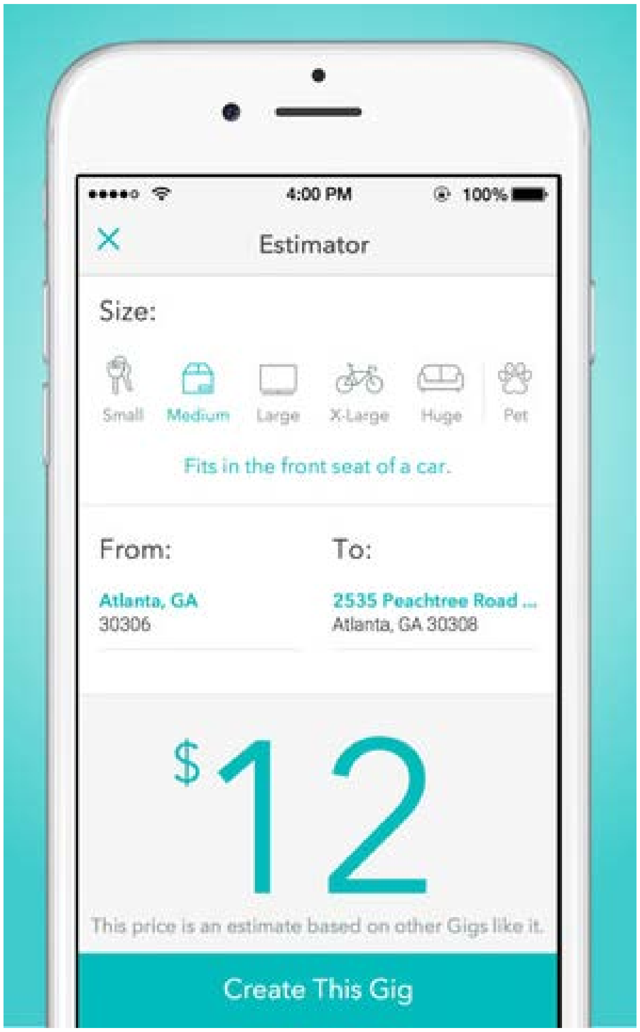

Figure 13. Screenshots of the Roadie app. Source: Apple iTunes Store

The second CNS model that has emerged is one in which for-hire ride services (e.g., ridesoucing) also conduct package deliveries. **Uber** has entered the paired on-demand courier network services market with **UberEATS** (food), **UberRUSH** (in New York City), and **UberCARGO** (in Hong Kong). **UberEATS** allows users to order their food from nearby restaurants and get it delivered on-demand and within a few minutes (three to 10 minutes in urban areas). As of April 2016, **UberEATS** was available in 12 cities around the world: Atlanta, Austin, Chicago, Dallas, Houston, Los Angeles, New York, Paris, San Francisco, Seattle, Toronto, and Washington D.C.

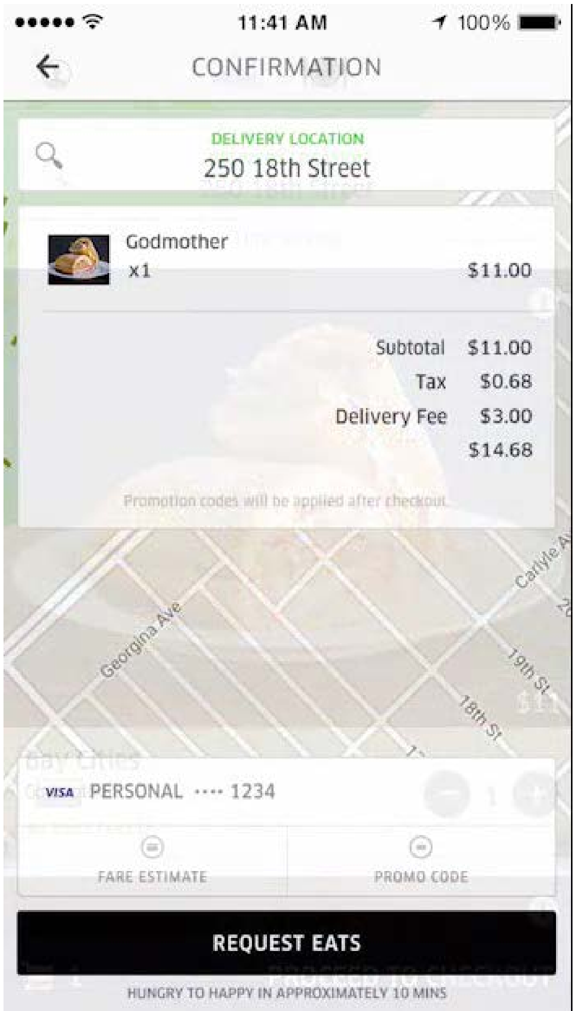

Figure 14. Screenshot for UberEATS app. Source: UberEATS Official Website

HEALTH APPS

Map My Walk is a health app (Figure 15) aimed at encouraging walking by providing GPS guided walking and health tracking features, such as distance and time walked, calories burned, and diet tracking. Other apps in this space include: **Pedometer, Walkmeter GPS Pedometer, Google Fit** and **Microsoft Health**.

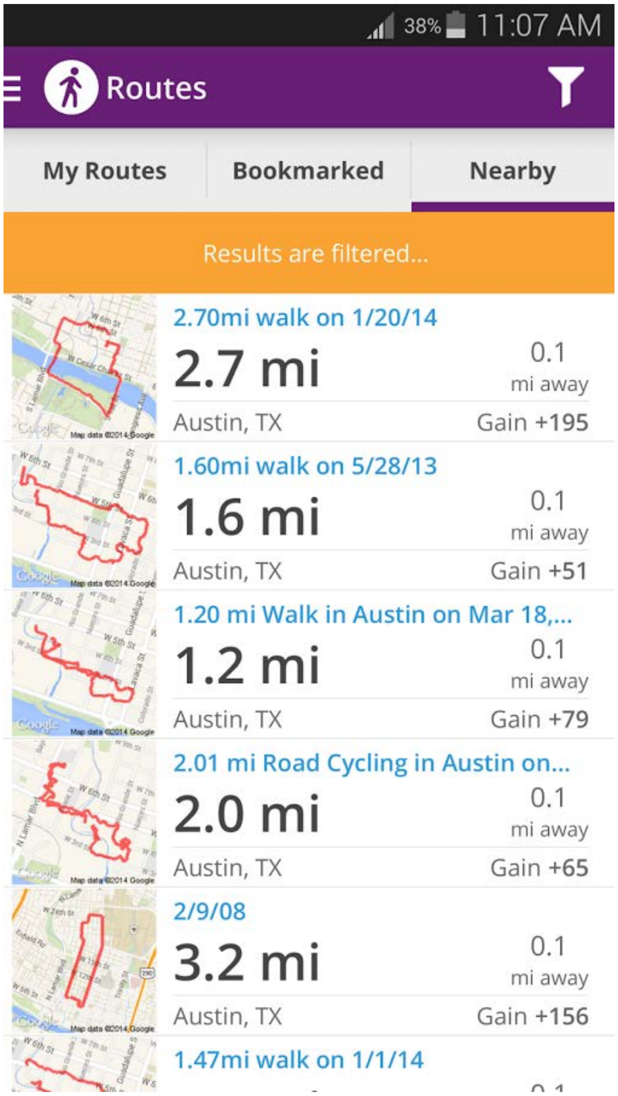

Figure 15. Screenshots from the Map My Walk app. Source: Google Play Store

ENVIRONMENT AND ENERGY CONSUMPTION APPS

TomTom is a navigation app (Figure 16) with an eco-friendly routing feature that allows drivers to select the most fuel-efficient routes.

Figure 16. TomTom app depicting its navigation routing feature. Source: Apple iTunes Store

Another example for environmental and energy consumption is **greenMeter** (Figure 17). It is an eco-driving smartphone application that computes a driver's vehicle power, fuel usage, and driving characteristics. The app uses these metrics to evaluate a user's driving and advises motorists on how to increase their efficiency, reduce fuel consumption, and reduce vehicular emissions. The app displays real-time results providing the driver with instantaneous driving feedback. Other apps in this space include: **EcoDriving** and **Geco**.

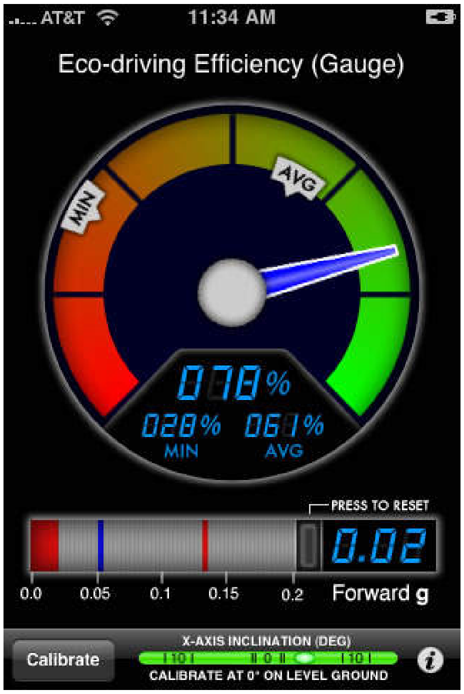

Figure 17. A screenshot showing the greenMeter app. Source: Apple iTunes Store

INSURANCE APPS

With the **Metromile** insurance app (figure 15), customers can "plug-and-play" a GPS and cellular-activated box into the vehicle's diagnostic port, which reads various metrics and diagnostic codes from the customer's vehicle and relays the info to the **Metromile** app on the customer's smartphone. Using the **Metromile** app, customers can select their deductible and view their insurance bill, which combines a flat base rate with a per mile rate based on actual vehicle usage. In addition to tracking insurance savings, the app also allows customers to track miles per gallon, fuel cost, and driving times. **Metromile** advertises that customers who drive less than 5,000 miles per year can save an estimated 40 to 50% off their insurance premiums. As of April 2016, **Metromile** insurance was available in California, Illinois, New Jersey, Oregon, Pennsylvania, Virginia, and Washington. Other apps in this space include: **Geico, Liberty Mutual, Progressive,** and **The General**.

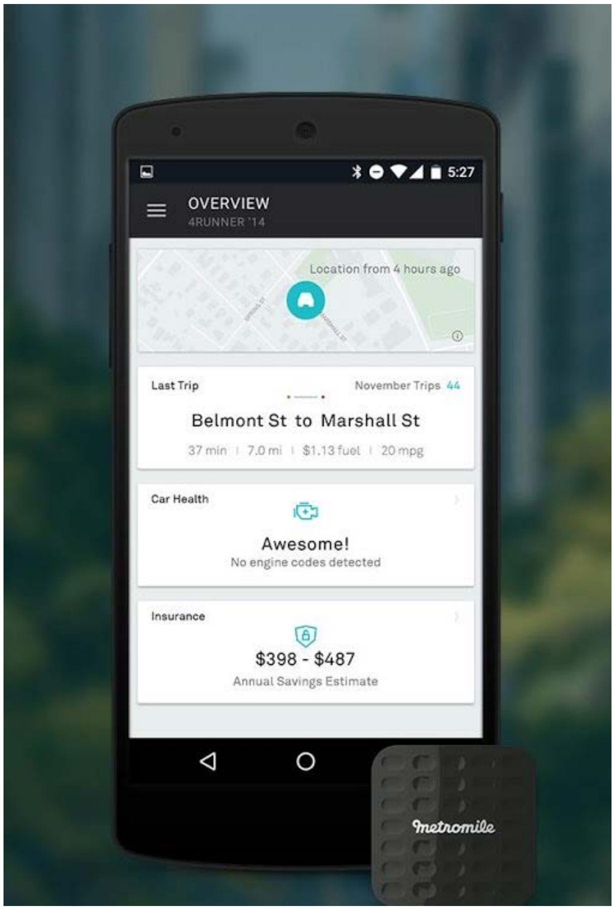

Figure 18. Metromile diagnostic plug and Metromile app depicting trip information. Source: Google Play Store

SUMMARY

In summary, mobility, vehicle connectivity, smart parking, courier network services, health, environment and energy consumption, and insurance apps are transforming mobility, improving access to transportation services, enhancing traveler engagement, and spawning innovative businesses, services, and mobility models. Android and iOS are the most common operating systems. Most mainstream transportation apps have limited availability on less common second tier operating systems, such as Windows and Blackberry. The vary majority of apps are offered free of charge in contrast to only 7% offered for purchase. Some of the free apps (17%) offer a freemium version with enhanced features or a user experience without advertising (n=14/82). Anecdotally, advertisers seem to be more willing to pay for ad impressions than users are willing to pay for applications without advertising and other premium services. The use of game theory and game mechanics, such as gamification and incentives, remain important elements of app design. Nearly one quarter of the transportation apps identified for this scan incorporated some form of gamified incentive. Incentives within mobile applications, such as incentives to download the app and incentives to use the app (or more specifically, gamified incentives that encourage or discourage a particular type of application use), are common strategies being employed by app developers to enhance user engagement and encourage user retention across a wide array of transportation applications. The next chapter reviews the behavioral and economic impacts of these applications.

CHAPTER 4. TRANSPORTATION APPS AND THEIR IMPACTS ON TRAVELER BEHAVIOR

Source: Thinkstock Photo

Smartphone apps have a strong influence on the travel choices people make. Much of this influence is economic and social psychological in nature. That is, smartphone apps often deploy psychological, cognitive, emotional, and social mechanisms to influence our economic and non-economic decision making. Transportation apps are no exception: whether it is the convenience of a ridesourcing app, like Uber; transforming the ride-for-hire industry; or expanding gamification opportunities on traffic apps, like Waze to develop ever smarter driver routing, transportation apps are profoundly influencing how travelers interact with the transportation system and traveler behavior. This chapter discusses how transportation apps may impact travel behavior.

There is simultaneously a huge variety of previously identified behavioral economic/social psychological mechanisms and very little specific research on their application in the transportation sector (Metcalfe & Dolan, 2012) (Solof, 2010). This primer identifies the mechanisms believed to be the most impactful and prevalent and describes, with examples, where and how they are deployed in current smartphone transportation apps (as of mid-2015). These mechanisms include:

1. **Cognitive Impacts:** How apps mitigate cognitive difficulties and drive new and different usage of the transportation system.

2. **Actual and Perceived Control:** How apps give travelers more or more perceived control over their travel choices and experiences.

3. **Privacy Safeguards**: The role of data privacy in shaping usage of apps and transportation behavior.

4. **Trust:** Limitations imposed on the potential of smartphone apps and transportation services by consumer trust issues.

5. **App Design:** How the design and user experience in apps impacts their usage and success in shaping behavior.

6. **Reframing Norms and Defaults about Transportation Choices:** Changing what travelers consider the "normal" or "right" choice for a given transportation decision.

7. **Price, Actual Value, and Perceived Value:** Impacting how travelers conceptualize and respond to transportation pricing.

8. **Information Availability:** How information in various forms, or lack thereof, can shape transportation behavior.

9. **Social Pressure:** How our social networks and connections are exploited by apps to change our choices and transportation experiences.

10. **Risk Analysis:** The impact of our perception of risk and how smartphone apps mitigate or increase it and thus influence our choices and behavior.

11. **Delivery of Incentives:** What smartphone apps do to shift our behavior with deliberate incentives.

Public agencies and governments need to better understand these mechanisms, how they are being deployed, and what benefits and costs they can incur for behavioral change in our transportation system. Each mechanism listed above is explored in greater detail below.

COGNITIVE IMPACTS

Smartphone apps are able to mitigate a number of cognitive difficulties, principally by reducing the cognitive effort required to make sense of complex situations and the steps required to achieve specific tasks. This is applicable for both the average user and those with cognitive challenges and disabilities (Szczerba, 2014).

One of the primary offerings of smartphones is always-on, always-connected, and at-your-fingertips convenience. Mobile devices enable users to communicate instantly around the clock, monitor financial markets, track weather forecasts, and get GPS guided directions in real time on an as-needed basis. In transportation, smartphone apps have made it easier to access and sort through complex public transit schedule data (e.g., Google Maps, Transit App, Moovit); alleviated the cognitive burden of route planning, both static and dynamic (e.g., Waze); and made it simpler and easier to pay for and access transportation services (e.g., TriMet ticketing, Zipcar app). Although smartphone apps in general may mitigate some cognitive difficulties, a number of studies have documented the negative impacts of the personal and business use of smartphones on employee productivity and sleep patterns and may be linked to stress and anxiety associated with social networking and compulsive checking for updates (Johnson & Barnes, 2014) (The British Psychological Society, 2012). In the transportation space, a growing body of research highlights the distracting impact of smartphone app usage on driving safety: whether checking social media, texting friends, or simply keeping track of smartphone route directions, studies indicate that the cognitive load involved is a serious distraction from safe and effective driving. Outside of driving safety, negative impacts on cognitive load in transportation choice and usage are unknown.

Apps deliver their cognitive benefits both through the physical nature of any mediated service (as in the case of Lyft or Uber) and through the design of the app itself. Transportation apps often involve search and decision heuristics, and how these are designed can have important impacts on whether or not the app is used and therefore whether or not it changes behavior. A well designed app will improve search heuristics by reducing the cognitive load necessary to make efficient and effective searches. It may also improve decision heuristics by making it easy to sort through options and come to a decision.

Ways in which app designs have been optimized to improve these heuristics include:

1. Providing users with immediate notification of an application’s status: trip aggregator apps, such as Moovel (formerly RideScout) and Citymapper, quickly take users from a trip plan to a full range of options that could meet their particular travel objectives. This reduces the cognitive load in searching for ride options.

2. Using a theme and visual language consistent with the offering and brand: ridesourcing apps, like Uber and Lyft, have distinct visual themes that often match their overall brand identity (e.g., sleek and efficient for Uber, more playful and social for Lyft) and help set them apart. Waze uses its icon consistently through the app and employs a cartoonish aesthetic that helps reinforce their primary value proposition as crowdsourcing user data for improved traffic routing. All these mechanisms reduce cognitive load in distinguishing between offerings and set up users for habitual and familiar use of these services.

3. Preventing errors where possible and assisting users when errors occur: Trip aggregator apps and public transit apps allow users to access public transportation schedules and route itineraries without access to the Internet. For example, Moovit crowdsources information from its app users to ground truth the public transit arrival predictions it receives from public agencies. These features can mitigate the significant cognitive effort necessary to respond to unforeseen failures in a particular journey (e.g., a missed bus or poor Internet connection).

4. Employing a simple, easy to read, pleasing, intuitive user interface: Regardless of the end objective of a particular transportation app, it is generally agreed that a simple and accessible interface improves user retention. For example, Lyft focuses on the one main goal users are likely to have when using their app, that is, hailing a vehicle. Their app is designed to emphasize the large button at the bottom of the screen that indicates to drivers that a user needs a ride. Lyft understands that the easier it is to request a ride, the more likely they are to see their service used.

While the user interface and user experience research supports the notion that design can significantly impact cognitive load and therefore user success in using an app, little publicly available research has been done on this in the context of the transportation world. Additionally, with an aging population in the developed world, heuristic practices for older adults that account for declining vision, hearing, motor skills, and cognitive function will become of increasing importance to ensure that transportation apps meet the mobility needs of disabled and older populations (Silva, Holden, & Nii, 2014) (Calak, 2013).

ACTUAL AND PERCEIVED CONTROL

App designers typically agree on the importance of user experience, interface, simplicity, reliability, and performance to designing a successful smartphone application. However, the actual and perceived user control that an app provides over a task or challenge are often overlooked attributes. Actual control refers to the explicit control an app user gains over some decision making process or experience. The underlying principle of perceived control is that the more a user feels in control, the more satisfied and comfortable they are. In the transportation space, actual control may relate to improving the user's sense of being on time or knowledge of when they will arrive: trip planning and public transit information apps from Moovit and Moovel (RideScout) through to Routesy and OneBusAway do so through accessing real-time data and providing timely and tailored updates. Perceived control may relate to the sense of material or security comfort while using a transportation service the user gains from employing an app, regardless as to whether or not that comfort is objectively improved. For instance, studies have shown that bus patrons without real-time arrival information perceive wait times as being longer, implying that apps providing real-time information can improve level of satisfaction from bus services (Watkins, Ferris, Borning, Rutherford, & Layton, 2011).

Studies on actual and perceived control benefits associated with smartphones are limited. However, according to one study, smartphone apps that enable riders more control over their trips may be the key to filling information gaps (Latitude, 2011) and by implication to enabling different transportation choices. According to their deprivation study, users that gave up a personal vehicle for one week wanted to be empowered and informed about available public transit options including: routing, electronic schedules, and system delays. Anecdotally, this study suggests that the new crop of informational apps— providing real-time updates on bus arrivals, for example—and innovative transportation service apps— providing access to taxis or ridesourcing within minutes—may be able to provide a level of control over personal transportation options comparable to a privately-owned vehicle. This has important implications for the modal share of drive-alone trips, particularly for commuting when high levels of certainty are required around arrival times. Informational apps that help mitigate the challenges of intermodal trips, particularly the issues of missed connections between multiple public transit services, could also increase public transit use in general.

The social networking capabilities of smartphones, independent of any specific transportation function, may play their own role in changing the transportation experience of travelers. Surveys have shown that "Millennial" demographic users favor smartphone ownership over car ownership because of the connectedness that such technologies enable: having dedicated time to access social networks may be a significant advantage to public transit ridership over driving (Tuttle, 2015) (Nelson, 2013) (Sakaria & Stehfest, 2013).

PRIVACY SAFEGUARDS

With many transportation apps tracking and storing sensitive information, such as user location data, concerns are emerging on how to safeguard user privacy (King & Raja, 2012) (Saif, Peasley, & Perinkolam, 2015), and on how this might impact usage of transportation apps and services. Ajusto, a transportation app released by Desjardins Insurance, tracks driver behavior in return for a promise of car insurance savings. As with many transportation apps that collect sensitive user data, Ajusto has critics worrying about how user location data are being used, such as the potential for data aggregation with other information on a user's smartphone and the sharing of user data to third parties (CBC News, 2015). Studies have shown, for example, that an individual's identity can be discovered purely by compiling travel habits in conjunction with other publicly available datasets (Rossi & Musolesi, 2014), (de Montjoye, Hidalgo, Verleysen, & Blondel, 2013).

Community-based navigation app, Waze; public transport app, Moovit; and community-based running and cycling app, Strava, are transportation apps revolving around the collection and analysis of user data. They raise questions about how these data are being shared, particularly as the three apps partner and share data with cities. Currently Waze, Moovit, and Strava only report sharing data that is anonymous and aggregated, but the potential for leaking or misuse remains (Forbes, 2014), and anonymizing/aggregation does not remove the potential to identify users based on detailed location information. To enable greater privacy controls for users and to combat privacy concerns, transportation apps that track location sensitive information, such as Strava, allow users to turn off the tracking in the app's settings, but it is not clear what happens to the data that may still reside on Strava servers. Typically, the answer may reside in the long and complex terms and conditions that every user implicitly signs but very few read (Gayomali, 2011) (Blodget, 2011).

While privacy concerns are often publicly raised, it is unknown if they have any significant impact on the rate at which these apps are adopted and therefore how transportation choices are made. Revelations from Uber of a "god view" where all vehicle and user locations could be seen from a central web portal (Dent, 2014) or explicit statements that user locations are being deployed as a central part of the app service (e.g., in Moovit's crowdsourcing feature for public transit arrival times) have not deterred the user bases of either company (70,000 users for Uber in San Francisco alone; (Shontell, 2014) and 10 million worldwide users for Moovit (Moovit, 2015)). It appears that anything other than gross breaches of privacy will not be sufficient to impact app use or app-mediated transportation services, but there is limited research on the subject, at present. It is likely that consumers balance app utility against perceived privacy breaches. In Lyft's and Uber's case, the powerful mobility benefits of having access to ridesourcing may in the traveler's mind outweigh the knowledge that user data are being collected and used for uncertain purposes.

TRUST

For a smartphone app to be effective, it usually has to meet the minimum standard of delivering on what is promised. This is particularly sensitive for transportation app providers, who may be fielding data on complex and unreliable public transit arrivals. Often, when there is a failure in real-time arrivals data (the purview of the serving agency), the party that is blamed is the transportation app, even if the app has no actual control over data quality (pers. comm. RideScout 2015).

More generally, having incorrect or missing information on roadway incidents, public transit departures and arrivals, and service availability can all undermine the trust and confidence of the user and may reduce the likelihood they adopt a particular app or service. For consumers using smartphone apps to access a particular product offering, such as a carsharing or microtransit, service reliability is particularly key. An unavailable vehicle or late driver, although again not necessarily the fault of the app itself, undermines the trust and confidence of the program. As such, real-time, reliable, and on-demand availability are the key characteristics contributing to a user’s trust in an application and may be strong factors in how impactful the app is in shaping transportation behavior and choice.

Trust is also about perceived/actual security and comfort in using a service. This is especially important with transportation apps that facilitate some type of ridematching, whether it be a ridesourcing service or casual carpooling. One mobile app, Slugg, has attempted to build trust among unknown carpool drivers and passengers by connecting app users to their company email addresses. Other apps, Lyft and Uber, attempt to build trust among for-hire drivers and passengers through the use of a public ranking system. In both cases, the mutual social screening that goes on can be a significant driver of trust in the safety and comfort of ridematching services.

REFRAMING NORMS AND DEFAULTS OF TRANSPORTATION CHOICES

Mobility apps are increasingly breaking traditional travel norms and instituting new patterns and habits. In the early years of smartphone apps, usage was mostly passive. For example, users might download an app with public transit timetables and reference their smartphone for static schedule information. The advent of high-speed mobile data coupled with GPS location services enabled a new change in travel norms: using smartphones for real-time mapping and mobility data (such as public transit information). Now users can get directions and destination information on a real-time, as-needed basis, breaking the prior norm of having to pre-plan journeys or use other static sources of information like paper schedules or websites.

Advancements in real-time technology now also enable travelers to alter their routing dynamically based on congestion and incident information. For example, the Here Drive+ app allows drivers to record various routes to work (Manticore blog, 2014). The app stores a commuter route, which can then be referenced by the driver in the future for side-by-side route comparisons with estimated travel time and bottleneck locations. Whereas the prior norm might have been that drivers accept being unknowing recipients of traffic congestion or public transit riders accept the inevitability of being subject to delays outside their control, real-time apps are changing these norms by placing more control and information in the user's hands. It is becoming more normal to plan dynamic trips because there is much greater certainty over available options and travel times due to real-time information.

Advances in mobile ticketing and access apps have impacted the norm of service access. When moving from one city to another, travelers might previously have had to relearn the unique means by which public transit tickets are priced, delivered, and validated in that new location. In addition, ticketing was often viewed as a time consuming transaction involving proper change, a fare agent, or both. The norms of assumed complexity and variability are being replaced now by new mobile ticketing apps in Phoenix, Portland, and Austin (GlobeSherpa, 2015) and elsewhere, which are standardizing and simplifying the process of buying and validating things like bus tickets (Linton, 2015).

Relatedly, there has long been a norm (and reality) of complexity in multimodal/intermodal trips. The challenge in navigating a bikesharing bike to a bus to a carsharing vehicle would, until recently, have defeated all but the most committed traveler. The smartphone and its transportation apps are increasingly enabling seamless door-to-door travel on multiple modes (e.g., Moovel, formerly RideScout). This is creating new informational and transactional norms, with digital wallets and wireless communication capabilities changing expectations for how easy the process of booking and accessing a particular service might be. Innovative transportation services that provide such amenities are increasingly in use (such as the dramatic growth of Lyft and Uber, where no cash ever changes hands) and putting pressure on traditional transportation modes, like public transit and taxis, to adopt and conform to these new expectations.

In recent years, smartphone apps have again caused a re-evaluation of travel patterns and habits by incorporating mobility matching, mobility networking, and real-time data to create a new travel experience. Today, smartphone users can use their devices to match themselves with other travelers to carpool, hire a driver, and rent their personal bicycle or vehicle, changing a number of different behavioral norms:

- Carpooling apps are breaking the norm that getting in a car with strangers is necessarily a bad thing. They are doing so by making the matching process easier and improving the verification process by which riders and drivers are matched (Kerr, 2014).
- Ridesourcing apps are breaking the norm that you need to be wealthy to have a private driver. Indeed, Uber's early marketing campaigns revolved around the slogan "Everyone's Private Driver" (White, 2012). They are doing so by disrupting the taxi industry so that any individual can operate an on-demand vehicle and making it easier and cheaper to access mobility services.
- Carsharing and bikesharing are changing norms around ownership of transportation modes. For long periods in the history of the automotive and bicycle industries, owning a vehicle was the primary norm: it was the gateway to mobility. But with the rise of carsharing and bikesharing services (Shaheen & Cohen, 2014) (Shaheen, Martin, Chan, Cohen, & Pogodzinski, 2014) and

apps that enable easy access to such services, the norm of ownership is beginning to evolve into a norm of access.

Smartphone apps can also impact defaults and norms through explicit and direct behavioral interventions (for example, rewarding a desirable behavior and punishing an undesirable one). These are distinct from app features of functionality that may change behavioral norms by virtue of their utility. There is limited research on deliberate behavioral interventions by transportation apps, but studies of smartphone apps in other sectors emphasize very few formal techniques for behavioral change, such as goal setting and self-monitoring (Nauert 2015).

Anecdotally, it appears that gamification is one of the primary behavioral interventions deployed in transportation apps. It is likely that apps, such as Waze, which gamify the act of providing transportation information (e.g., reporting an accident), have done so with the deliberate intent of shaping behavior toward the goal of generating more real-time information on traffic incidents. Given that Waze now provides data to multiple cities (Waze, 2015) and to the Google Maps application (Google, 2015), gamification is emerging as an effective intervention to shape behavior. In terms of norms, Waze is changing perceptions of the level of connectedness of individual drivers and the value of their own information. Moovit, a public transit information app, also deploys a form of gamification but in the public transit space. Moovit awards points to users for reporting late arrivals, incidents with vehicles, and other information pertinent to other travelers (Moovit, 2015). How successful this mechanism is in attracting new users or driving public transit ridership is unknown, but Moovit is doing its part to shift norms around the value of any individual traveler’s experience to operation of the wider system.

Transportation app interventions may improve policing and security. The Bay Area Rapid Transit (BART) District, a San Francisco Bay Area transit agency, recently launched an app for policing. This app provides tools for users to report potential criminal incidents on the subway. Such an app may be primarily oriented toward helping the BART police secure the system, but it may also have the behavioral effect of discouraging criminal activity (similar to the effect of having security cameras on public transit (Nieto, 1997)). In the vein of punishing and stopping bad behavior, apps like TowIt (recently launched in several U.S. cities as of mid-2015) seek to empower the majority of the traveling public against a scofflaw minority. TowIt allows users to report double parked or otherwise obstructive vehicles with license plate recognition and an interface for the police or other authorities to review the offenders and presumably take action (CBS San Francisco, 2015). This is a behavioral intervention to punish violators for an actual offense, but it is also attempting to curtail double parking, which remains far too prevalent.

PRICE AND VALUE IMPACTING APP ADOPTION AND USAGE CHOICES

Transportation apps on smartphones may shape behavior by changing perceptions on price and value. This is in terms of purchase/use cost, actual value for money, and perceived value on both monetary and non-monetary grounds. Transportation apps may both increase awareness of favorable price/value (e.g., mode comparison apps) and actively drive down the cost of a transportation service through a linked transportation mode (e.g., Uber or Lyft). Finally, transportation apps may change the value equation by either providing additional non-monetary benefits or making other non-monetary benefits more prominent to the consumer.

At the most basic level, app purchase price is believed to impact a consumer's choice on whether or not to use an app. As of 2013, 90% of apps across iOS and Android were free or ad supported—an increase of 84% from 2010 (Gordon, 2013). Clearly, transportation apps that are freely available are likely to be downloaded more. But this is only part of the story.

Public transit apps that convey fare information or aggregator apps that allow comparisons of fares across services (e.g., What's The Fare (What's The Fare, 2015)), may act to commoditize transportation in favor of users (driving down prices), as well as shape choice toward cheaper options. The price elasticity of multimodal travel is not well understood, however, and convenience, comfort, trust, safety, and reliability may come above the price of a service in determining choice. Nevertheless, improved pricing information—particularly for complex journeys—can have an impact, and smartphone apps are a highly effective way to deliver this information.

App-based services, like Lyft and Uber, have expanded the on-demand mobility market by competing alongside legacy taxi services, increasing the supply of drivers, and driving down prices (although some of this price depression may well be subsidized by both companies in an attempt to corner market share (Said, 2014)). Such apps and associated services create perceived consumer value through enhanced services (e.g., digital dispatch and on-demand vehicle tracking), making the expense of paying for a private car seem a better value for the money.

Consumer "value" is not always about lower prices or indeed about prices altogether. New companies, such as Leap in San Francisco (now defunct) and Von Lane in Texas (Leap, 2015) (Box, 2014), offer "enhanced" transit services with more comfortable vehicles and amenities like onboard drinks. These are higher priced offerings that provide more "transportation experience" value, which their apps publicize. In the same vein, apps that provide access to environmentally-less costly transportation services, like Scoot Networks (an electric scooter sharing system in San Francisco), may shift behavior toward those modes both by simply making it easier to do the right thing and also publicizing the benefit of doing so to others (Welch, 2009). Apps that offer convenience value (e.g., time savings, access to smartphones while on the move) may be particularly impactful in shaping behavior, even if the financial cost is ultimately greater. Similarly, purely informational apps that make it easier to use public transit services may enhance the perceived value of such services by expanding notions of what trips can be conveniently made on transit, and they may help to dismantle notions that public transit is necessarily unreliable or only for people with no other options.

INFORMATION AVAILABILITY

Transportation of any kind is a complex activity, requiring integration of multiple kinds of information to successfully execute any given trip. This is true of all modes, but particularly so for non-drive alone modes, where having incorrect information or not understanding the complex information available can be a barrier to successfully getting from origin to destination. Imperfect information about alternatives, difficulty comparing alternatives, and challenges with multi-modal integration generally lead to behavioral biases toward particular modes, like driving alone.

Transportation apps act to address this information availability problem in a number of ways:

- Schedule information apps, which gather and parse public transit schedule data, static or dynamic, and present it more simply and accessibly for the user. Such apps shape behavior by reducing fear of failed trips using public transit modes and overall cognitive load in configuring such trips. Transit Screen, Transit App, Moovit, One Bus Away, and any number of public and private apps meet this profile.
- Mode aggregator apps, which pull in availability and schedule data on multiple different public and private modes, remove the information/awareness barrier to using different modes. Moovel (formerly RideScout) is an example of this approach, but increasingly other public transit information apps, like Transit App and Swiftly, are starting to integrate other modes (Transit App, 2015).
- Real-time incident reporting apps seek to raise awareness of issues and problems arising during the journey. Google Maps apps for Android and iOS now offer dynamic re-routing to avoid traffic problems in real time (Torres, 2014); Moovit tracks real-time locations of its users and self-reported incidents to adjust predictions for other users (Moovit, 2015); and apps like CaltrainMe integrate social media feeds to quickly funnel problem reports with train services direct to users (CaltrainMe App, 2015).
- Providing price and quality information: Studies suggest that consumer purchase decisions are impacted by three strategies: 1) best value, 2) highest quality of service regardless of price, and 3) price aversion (Tellis & Gaeth, 1990). Best value is choosing the mode with the highest value-to-cost ratio; highest quality of service is selecting the best service regardless of price; and price aversion is selecting the lowest cost alternative to minimize costs. Transportation apps support these three strategies in a number of ways. Numerous aggregator and trip planning apps (e.g., Moovel (formerly RideScout), Google Maps) communicate cost and service information (including anticipated trip time) so a best value decision can be made, as well as supporting a simple price aversion search where the lowest cost service is sought regardless of quality. The wide variety of apps providing access to specific niche services, some more luxurious than others (e.g., Von Lane, Uber, Bridj, Chariot, Via), assist those seeking the highest quality of service regardless of price, with aspects of their design and branding signaling the higher service quality.

It is arguable that the first and best role of transportation apps changing behavior is through their information provision functions. However, with the predominance of transportation information being held publicly and the majority of transportation apps being developed by private companies, a data transfer gap exists that can limit app success. If real-time data are not available for a given service, few apps can address this, although efforts by Moovit and others to develop crowdsourcing tools can help to remedy gaps.

SOCIAL PRESSURE

Facilitating connections into, and awareness of, social networks and social messaging are bedrock features of the smartphone app ecosystem, whether transportation-focused or otherwise. Some of the most successful deliberate behavioral change interventions in the energy, environment, and infrastructure sectors have involved leveraging social dynamics (Opower, 2015). This is with good reason: people are likely to adjust their behavior in response to social psychological mechanisms (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007) (Lindenberg & Steg, 2007). Transportation apps may be leveraging and deploying these mechanisms in a number of ways.

- Community building is an effective and widely used mechanism to exert social pressure and shape behavior. For example, Waze makes users feel as though they are part of a unique and exclusive community by deploying instruments to convey a strong identity. This might entail customizing cartoon avatars for each user or the ability to "like" other user's recommendations. By showing the locations and avatars for each user on a live map that all users see, Waze is deploying a mechanism called "social proof" (Cialdini, 2006), where a particular behavior is encouraged by providing examples of other people already doing so. Both the community building and social proof arguably increases trust in Waze's navigation recommendations, which may in turn feedback into a greater propensity on the part of individuals to supply more information about their own driving experience.
- Both Waze and other crowdsourced data apps, like Moovit and GasBuddy, deploy competition and status seeking to drive desired behavioral change. Reporting incidents on these apps can lead to accumulation of points and/or status of some kind (perhaps a new avatar that signifies seniority in the community). In some cases, these apps provide leaderboards as a competitive gamification mechanism to further increase engagement.
- The urge to conform to established social norms can be a powerful motivator. This force is evident in the mutual ratings systems deployed in a number of transportation apps, particularly those where trust and security are a concern. Ridesourcing services, such as Lyft and Uber, allow passengers to rate their driver and drivers to rate their passengers (Uber, 2015). The driver star rating is presented to passengers and used by Lyft and Uber to weed out underperforming or problematic drivers. The passenger rating is presented to drivers when they are agreeing to pick up a hail request, and they have the option to reject if the star rating is too low. These generate subtly different but nonetheless firm social pressures to be a "good" participant in the ecosystem. Such mutual pressures not only ensure smooth operation of the service and a great ride for customers, but they may also attract additional users to the service given their implied promise of a trustworthy and safe experience. It is important to note that

improving safety (e.g., biometrics, licensing) across these platforms is a separate issue from the psychological issues addressed through encouraging trust on the platforms through star ratings.

- A variant of conforming to social norms is the use of shadow policing as deployed by carsharing services, like Zipcar and car2go. This takes the form of a requirement to report vehicle damage at the beginning of a carsharing reservation (Zipcar, 2015). It provides a strong incentive to users to both avoid blame for damage by making an early report and to avoid damaging the vehicle in the first place since the chance of being reported by the next user is high. While this mechanism was deployed long before smartphone apps arrived, apps for both services are now easing this reporting and making it easier to track the condition of a vehicle before booking (car2go, 2015).
- Some apps are generating entirely new social norms and using them to attract users. The PlugShare electric vehicle services app encourages private owners of electric vehicle charging stations to share their equipment with other users of the PlugShare app. This is currently a fee-free service, but PlugShare encourages beneficiaries to leave tokens of thanks, such as gift cards or a bottle of wine (Tesla, 2015). This new norm encourages existing sharers to continue providing free electricity, and other PlugShare users to join the community.

Social psychology is rich with heuristics and interventions that purport to change human behavior in response to social cues or pressures. Transportation apps have barely scratched the surface of what might be possible, but success with Lyft's and Uber's mutual ratings system and Waze's gamified community, for example, suggest notable future potential.

DELIVERY OF INCENTIVES

Incentives, rewards, and loyalty programs are a long-standing mechanism for changing behavior. Retailers have long issued "punch cards" to reward loyalty and repetitive behavior. Increasingly, smartphones applications are using both broadcast and segmented incentives in an effort to impact behavior, often through gamification. Psychologists and marketing professionals have argued that the closer a user gets to a reward, the more motivated they become to follow through (Wax, 2015). Transportation apps deploy a wide range of incentives.

Taking perhaps the simplest approach—financial incentives/rewards for specific desired behaviors—both ridesourcing and e-Hail taxi apps regularly deploy ride credits for downloading, using and sharing their services. These typically range from $5 to $25. Uber, for example, offers a bonus of the same magnitude to third-party transportation apps integrating Uber's services through their Application Programming Interfaces (APIs), as a reward for attracting new users onto Uber's platform. They have also advertised a tiered pricing incentive for existing drivers to encourage heavier use of their service by drivers. Incentives are also widely used outside of on-demand ride services. Parking apps, like BMW ParkNow and ParkingPanda, offer discounted parking for users of the service. The GasBuddy app (helps drivers find locations of gas stations and provides prices) enters users into a drawing for $100 in free gas, if they report a local gas price (Gas Buddy, 2015).

A variant of the classic financial incentive is to offer points or non-monetary currency, much as airlines have offered for decades through frequent flyer programs. The GasBuddy app offers non-monetary currency by rewarding users with 200 points for posting and updating a gasoline price. Accumulated points may be redeemed to participate in prize raffles. The Changers app helps reduce a user's carbon dioxide (CO2) footprint by tracking their transportation-related CO2 emissions (Markham, 2014) and uses a virtual "green currency" as a proxy for personal carbon offsets. By tracking a user's trips, travel modes, and distance, the Changers app calculates a CO2 value for each journey and then adds or subtracts "ReCoins"—a virtual currency within the app from the user's balance. By forecasting a CO2 balance for the trip, the app awards or penalizes ReCoins based on whether or not a user saves more CO2 than the forecast estimates for that trip. The currency can be used to "buy" offsets for other trips that have higher CO2 emissions. More generally, transportation app usage of points are typically categorized into one or more of four types (Zichermann, 2011):

1. Experience points: Points are awarded for simply participating on a regular basis in the app. Waze and Moovit are prime examples of awarding experience points for basic interactions. Such repeated awards create habits of using the app and associated services.
2. Redeemable points: These points are awarded (or purchased) in-app and redeemable within the app ecosystem. These are common for airline frequent flyer programs and are also used by Amtrak and some rental car companies. Not surprisingly, they have considerable potential for keeping users entirely inside a given transportation service. They have also been deployed by public-minded transportation apps, such as NuRide, Stanford University's CAPRI, and now just beginning with Metropia, to reward both transportation alternatives to driving alone and congestion avoidance when driving.
3. Skill points: Such points are awarded for the completion of a particular task in-app or using the service. An example is GasBuddy, which awards specific blocks of points for reporting gas prices. Waze has a complex system of points awarded for different tasks, such as "resolve 50 map problems" and "complete 500 map edits" (Waze, 2015). While not explicitly involving points, some services, like Scoot Networks, in San Francisco progressively reveal app functionality in return for users completing important training and qualification tasks (like learning how to ride an electric scooter).
4. Reputation points: The mutual rating systems provided by Lyft, Uber, and other ridesourcing companies through their smartphone apps are a form of reputation points, forming the basis of mutual trust in their services.

Incentives in the form of discounts on third-party services or products are a common motivator across retail and advertising. Transportation apps and services are also starting to explore their potential. Public transit agencies, like TriMet, are experimenting with pushing location-aware promotions to encourage ridership growth on new and existing transportation lines. In Montreal, the STMMerci public transit app rewards riders with location and use-targeted discounts from 340 enrolled merchants and 1,000 event partners to reward riders based on how often they use public transportation. Top-tier riders are offered a 50% discount on a product or service, second-tier riders receive a 30% discount, and third-tier riders receive a 10 to 15% discount. Non-currency incentives can be just as effective as monetary ones when delivered directly, and better yet, they can compound the benefits of monetary incentives when concurrently provided. Indeed, many of the other mechanisms discussed in earlier sections are non-financial.

CONCLUSION

It is clear that behavioral mechanisms from economics and psychology are already being deployed widely in transportation apps, with a variety of benefits. Some of these benefits include:

- Alleviating cognitive burdens with powerful search tools (e.g., Google Maps);
- Improving actual and perceived traveler control over journeys (e.g., OneBusAway);
- Improving trust in carpooling services (e.g., Carma);
- Changing norms around transportation, such as the ease of mobile ticketing (e.g., RideTap formely GlobeSherpa);
- Impacting price directly by enabling cheaper services (e.g., Uber) and changing perceptions of value across multiple modes (e.g., Moovel, formerly RideScout);
- Improving information availability and so shaping service usage (e.g., Transit App);
- Harnessing existing social pressures and generating new ones to shape travel behavior in a desired direction (e.g., Waze); and
- Delivering financial and non-financial incentives in favor of one behavior or another (e.g., GasBuddy, Changers).

Sometimes these economic and social psychological mechanisms are deployed for the sole benefit of the app developer. More commonly, however, these mechanisms are driving both app usage and positive benefits to the consumers and the wider transportation system. For example, Waze's multiple use of gamification mechanisms and its popularity led to an acquisition by Google and the use of their data by a number of major U.S. cities (Olson, 2014). Public agencies have not been as successful as private app developers in fully benefiting from their apps or the data that they make available for private apps. For example, public transit agencies open up their real-time arrivals data, and both the apps and users benefit, but it may also be worthwhile considering ways to bring benefits back to the agencies (perhaps in the form of sharing real-time usage data to help operators improve services).

The wide usage of behavioral economics and social psychological principles in apps suggests the importance of understanding the theory and practice of behavioral change in the context of smartphone apps for transportation. Additional work would help to test some of the hypotheses and build on anecdotal evidence that successful behavioral change mechanisms from other sectors can be usefully deployed to change transportation behavior. The next chapter reviews opportunities (e.g., planning and data collection) and challenges (e.g., privacy and digital divide), as well as best practices for deploying smartphone apps.

CHAPTER 5. CURRENT CHALLENGES

Although smartphone apps have become ubiquitous, a number of significant challenges remain for app developers, mobility service providers, and public agencies. Five key challenges affect the adoption and effectiveness of smartphone apps, and best practices to overcome these challenges are explained in the following section.

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PRIVACY CONCERNS

Numerous studies indicate that people are either unaware of what private information they are exposing or they do not understand what information they are consenting to share (Miller, 2014). Privacy policies for most software companies and app marketplaces (e.g., Apple, Google) are often written in legalese, making user agreements long, confusing, opaque, and challenging to understand for the vast majority of users. All too often, app marketplaces have multi-page user agreements with fine print that software companies "expect" users to read and provide consent. For example, Apple's iTunes user agreement contains 56 pages that users are expected to read, tap, and agree (Pidaparthy, 2011). In many jurisdictions, selecting "agree" constitutes an electronic signature akin to typing your name in an email or signing a document with a pen. In other cases, apps may intentionally or unintentionally collect a wide array of sensitive and personally identifiable information (PII), such as location history, email addresses, phone numbers, financial information, and usage history of the apps installed on their phone and mobile Internet browsing history. Privacy and security concerns are further complicated because vulnerabilities may exist on many different levels, such as through the app, API[3], the cloud, or hardware.

One possible privacy breach may occur between apps and APIs. According to a recent report by the analytics service "SourceDNA," hundreds of apps in the iOS App Store were extracting PII user information via private APIs, although Apple had forbidden the apps from engaging in this type of practice (Perez, 2015). The report found that the applications in question had been using a software development kit (SDK) from a Chinese advertising company called "Youmi," which was accessing this information by way of private APIs. After confirming its validity, Apple responded by banning numerous apps from its marketplace. Privacy breaches have impacted and have been a notable concern among other operating systems as well. Google has stated that any new APIs being proposed must

[3] An API, short for "Application Programming Interface," is a set of routines, protocols, and tools for building software and applications. APIs can help developers and smartphone apps share data and information between apps and make it easier third parties to develop apps and incorporate features from existing apps.

either be "safe" by default, or in the case where some capability is being granted that may negatively impact the user's security or privacy, this capability should be granted through a user interaction that is natural and understandable to the individual (Fetter and Eisenger, 2013).

In addition to security, there are growing concerns about the use of sensitive geospatial user data. In June 2015, the Electronic Privacy Information Center (EPIC) revealed that Uber would soon track and report back the whereabouts of its users even when they are not using the app (Thomson, 2015). Specifically, EPIC claimed that the ridesourcing app collected the location of its users via their smartphones' GPS tech even if the app is running in the background unused. EPIC further claimed that if a user switches off the satellite service, the app would continue to use the smartphone's IP address to approximate the user's geographic location. Similar reports indicate that other apps both in the iOS and Android environment use location data of their users to provide them customized service (Thurm, 2010). This represents one example where users may not understand the type and implications of the data they are sharing on their smartphones.

Cloud privacy can also be a significant user concern. Increasingly users are backing up data in the cloud for convenience, multi-device access, back-up, and storage expansion. Users may not be able to opt-out of this functionality. For example, Apple requires its iPhone users to create a mandatory iCloud account, where it backs up all data from the smartphone, including deleted data. While Apple insists that the data are secure and no one but the user can access it from their iCloud accounts, recent cases where personal pictures of celebrities were hacked from their iPhone and iCloud accounts may indicate possible security vulnerabilities with cloud storage systems (Whitman, 2015).

While improving the privacy of all app users continues to evolve, a few significant developments are strengthening user privacy. Google has introduced stricter rules for Android applications to reduce the number of malicious apps in the Google Play app market (Ashford, 2012). Developers have been warned that apps that introduce security vulnerabilities, spread malware, collect information without authorization, or "harm user devices" will not be permitted in the Google Play Store. Malicious scripts and password phishing scams are also now prohibited on Google Play, as are applications that cause users to unknowingly download or install apps from sources outside of Google Play. Apple is also focusing on privacy. To address the "fine print" and "legalese" challenges associated with privacy and user agreements, Apple has started introducing user agreements written in clear language in the new iOS9 update (Panzarino, 2015).

When it comes to privacy issues—whether at the app, cloud, or smartphone level, privacy is a two-way street. End users should exercise caution and due diligence in reading the privacy policies, be aware of spam links, and avoid "copy-cat" versions of mainstream apps. Likewise, app manufacturers have an obligation to design their apps to provide necessary security, and app marketplaces could play an important role in ensuring that apps distributed on their sites are secure and free of security vulnerabilities and malware. Public agencies and governments may be able to address a wide array of privacy issues through security standards and consumer privacy protection laws.

OPEN DATA AND INTEROPERABILITY AMONG SERVICES AND MODES

It is common for apps to share data with third-party apps and services (including APIs) to provide a seamless user experience and enhanced functionality. Most location-based services, such as Google maps, use search histories to recommend and advertise an array of products and services to their users. For example, when a user searches “Starbucks” on Google, the search usually includes a map of the nearest Starbucks outlets at the top of the search browser. Similarly, an app, such as “Moovel,” which is a multi-modal trip aggregator, uses data from public transit apps and traffic data to provide the user the “optimum” multi-modal route available, based on user preferences, such as least expensive fare, fewest transfers, shortest waits between connections, etc. Although open data has provided new opportunities, it also creates a number of challenges for app developers and end users.

One major challenge for app developers is the need to design the same app for several mobile operating systems, such as iOS, Google Android, and Microsoft Windows. Different operating system and marketplace requirements make it difficult and costly for developers to create cross-platform apps. Similarly, creating a uniform look and feel across devices can also be a challenge. Replacing native apps with browser-based functionality that can work across platforms may be one way to address this challenge.

As previously discussed, privacy challenges also re-emerge with open data and data sharing among services. Any API that facilitates data sharing among apps without user consent can create a number of ethical and legal issues. How much data are wise to share among services and how best to protect these data can vary by circumstance. Generally, providing the end user with a very clear and limited consent process is a best practice. For example, rather than having an end user consent to sharing all data with third parties, allowing a user to choose what data to share is more ideal (e.g., billing information, travel history, search history, etc.). This gives users more transparency and control over the type and extent of information they share with third parties.

Data can broadly be divided into three types: 1) open data, 2) proprietary data, and 3) personal data. Open data are data that are publicly available for download or through APIs. Proprietary data are data related to the company or corporation including copyright, patent, or trademarked material (e.g., proprietary code). Proprietary data can also be important to a company’s business plan or growth strategy. In contrast, personal data includes email addresses, phone numbers, and other PII. Personal travel behavior (e.g., origins and destinations) and IP addresses (to the extent that they can identify a particular individual or location) also constitute personal data. Protecting all three types of data, while still enabling information sharing with other apps and services, is a continual challenge confronting developers. Industry-wide security standards, data sharing practices, and common computer languages may assist in addressing this challenge. Increasing public awareness is also important so that people understand the benefits and risks associated with sharing their personal information (Roberts, 2014).

APP AUTHORIZATION

In many cases, users must download smartphone apps through an app marketplace maintained by the operating system manufacturer (e.g., Apple's App Store, Android's Google Play, etc.). A developer interested in publishing their app initiates a request to the operating system manufacturer (e.g., Apple or Google). This is designed to keep the app ecosystem healthy and to protect users from low-quality, insecure, or malicious apps.

Based on nearly 70 reports released by developers in 2014, it takes an estimated eight to ten days for Apple to approve a new app in its App Store and an average of seven days for Android's Google Play marketplace. Apple has reported that the iOS App Store had approved 89% of new app submissions, and 95% of submitted app updates, within eight business days (Friedman, 2012). Other reports have cited a lengthier app approval process, averaging 22 days (Friedman, 2012). A lengthy approval period could create problems for app developers, particularly when they attempt to quickly push an update to address compatibility issues, correct critical errors, or fix security vulnerabilities. Often times app developers are at the mercy of app marketplaces; however, accelerated approval processes and increasing awareness of this challenge by app marketplaces may be mitigating this developer concern.

One strategy to overcome the delays associated with app authorization is for companies to develop mobile websites (accessed via a mobile web browser) instead of a native smartphone app. Many experts believe that smartphone apps may be replaced by mobile websites in the long run (Magid, 2015). Similarly, Google also stated that it believes apps may be replaced with mobile sites (Magid, 2015). Mobile web-based platforms not only address challenges associated with app authorization delays, but they can also relieve app marketplaces of potential liabilities associated with security vulnerabilities and address cross-platform compatibility issues, negating the need to develop operating system specific apps.

ACCESSIBILITY CONSIDERATIONS

Another challenge confronted by public agencies, app developers, and manufacturers is how to address accessibility issues related to smartphone apps.

Bridging the Digital Divide

Mobility consumers are becoming increasingly dependent on smartphone hardware and applications, and the data packages required are often expensive for low-income households. While some state and federal programs exist to provide reduced cost mobile service, more education and outreach are key to promote these programs, and program expansion and additional programs are also needed.

In 1997, the Federal Communications Commission (FCC) established the Universal Service Fund (USF), as part of the Telecommunications Act of 1996. One key program component, known as Lifeline, provides a subsidy of up to $10 per month for Americans below 135% of the poverty line for land line or mobile service (Phillips Erb, 2012). In 2015, the maximum income threshold for the contiguous U.S. was $15,890 and $32,734 for a household size of one to four, respectively (United Service Administrative Company, 2015). As of 2012, 17 million households received a $9.25/month subsidy through the program (Malter, 2012). In 2012, the FCC announced its intention to transition the Lifeline program from basic mobile phones to Internet-capable smartphones (Henry, 2013) (Federal Communications Commission, 2012).

Service and Data Limitations in Rural and Less Urbanized Locations

Some mobility services may not be available in less urbanized and rural areas. Moreover, data speeds and service quality may limit the use of smartphone applications in less urbanized and rural locations. The end user experience of any smartphone app depends on not just the way the apps are coded, but also on numerous external factors, such as Internet availability, quality of the network service, and hardware limitations.

Most apps that provide real-time data services require a continuous high speed data connection. This may not be readily available in many rural areas nor affordable to low-income users. Slow Internet speed and limited data availability represent a notable accessibility challenge: many users may not upgrade their apps when an upgrade is available because of limited data constraints. When app developers add new features and fix various problems through upgrades, not installing updates can limit user's ability to benefit from new features and security updates.

To address the challenge of providing a similar experience for all users irrespective of data speed constraints, many companies have started designing a "lite" version of mobile sites and apps (Felker, 2012). These lite versions may not result in less end-user functionality but instead restructure data use through data caching and asynchronous data exchanges (e.g., supplementing download data through WiFi connections). In addition to consuming less Internet data and operating on low speeds, lite versions of apps may also help conserve smartphone battery life.

Unbanked Users

Smartphone apps with a payment component may not serve the needs of unbanked users (typically lower-income households). Many smartphone apps generally require payment facilitated through credit/debit cards or mobile/Internet banking. If a user is unbanked (they do not have a bank account or a credit/debit card), app-based services with a payment component (e.g., electronic fares and ticketing) may be difficult or impossible to use—leaving behind households that cannot afford to have a credit card or bank account (due to insufficient funds, bad credit history, etc.).

To address this challenge, services may consider allowing alternative payment methods, alongside cashless transactions or programs to bank unbanked users. New programs are now being developed to assist unbanked users open a bank account (Helhoski, 2014).

A common concern among bikesharing operators and local governments is low-income access to bikesharing and the requirement to have a debit or credit card for use. In Washington DC, **Capital Bikeshare** partnered with United Bank and District Government Employees Federal Credit Union (DGEFCU) to allow users to open up a bank account and obtain a debit card. New account holders receive a $25 gift card good toward the cost of an annual Capital Bikeshare membership (Capital Bikeshare, 2015).

Source: Thinkstock Photo

Addressing Special Needs

Another accessibility issue is ensuring that smartphone apps are accessible to all users. Accessibility requires apps to be usable by people with various health conditions (primarily older adults), as well as disabled individuals who need assistance. Although the smartphone apps of today have improved tremendously in design, user interface, and power, there has been less progress toward making these apps available for the visually impaired or users with learning disabilities.

For example, Uber has partnered with the National Federation of the Blind and Lighthouse for the Blind in San Francisco to test VoiceOver iOS compatibility that allows blind or visually impaired riders to speak to their Uber app (Uber, 2015). Lack of information about available ADA accessible options may adequately serve all users. For example, some parking apps enable users to access real-time information about parking availability and pricing but exclude information on disabled parking.

Technology manufacturers and app developers are making some progress. For example, Apple has released a list of more than 50 apps that are specifically designed for blind and low-vision users (Apple Vis, 2014). However, this represents only a very tiny fraction of the overall number of apps available on its marketplace. Public agencies, app developers, and marketplace stewards should move toward ensuring that all transportation apps provide user interfaces that serve individuals with special needs. Similarly, special attention should also be given to the user interface, keeping in mind that users may have special needs, such as older adults who may have difficultly operating a smartphone with a touchscreen. Such innovations are needed to ensure that transportation apps provide mobility and accessibility for all segments of society.

ADDITIONAL CHALLENGES

For app developers, a few other challenges exist. For example, as previously mentioned, another challenge is the interoperability across a growing array of devices and operating systems. In recent years, there has been an increasing number of devices with varying hardware capabilities and screen resolutions (e.g., desktop computers, notebooks, 2-In-1 devices, tablets, smartphones, smart TVs, and wearable devices, such as watches, bands, and glasses). Providing apps for all of these devices is becoming increasingly challenging and expensive for developers and their companies. Additionally, it takes time to develop, test, re-test, and deploy an app across these devices. With new devices and technology entering the marketplace daily, it is increasingly difficult for developers to keep pace with these advances. The release of Windows 10 may be able to address some of the technical challenges associated with interoperability across a growing array of devices. Windows 10 offers developers the ability to create “universal apps” that can seamlessly run and scale across a spectrum of devices, ranging from phones to desktops.

In addition to interoperability challenges, companies must be able to generate sufficient revenue to support the development costs associated with creating and maintaining their apps. In recent years, both ad blocking apps and add-ons have become more commonplace. For example, in its latest version of iOS, Apple has allowed users to block ads on the safari browser and several apps (Tsukayama, 2015). Most developers and companies oppose this feature because they interfere with their ability to generate revenue and provide free or reduced cost services to end users. Most free apps in the marketplace generate revenue from in-app advertising or in-app purchases. Google’s Senior Vice President of Advertising and Commerce, Sridhar Ramaswam, recently said that the industry must agree on advertising standards and address sites that have poor advertising practices (D'Onfro, 2015).

CHAPTER 6. GUIDING PRINCIPLES FOR PUBLIC AGENCIES

With the growing popularity of smartphone applications, it is helpful for public agencies to recognize several guiding principles when considering the role and implementation of smartphone apps on a transportation network. These principles reflect current understanding, which will undoubtedly continue to evolve. These guiding principles include the following.

DATA SHARING AND INTEROPERABILITY

Data sharing and interoperability will form the foundation of transportation apps, in particular mobility apps. Public and private entities could play a critical role in facilitating and defining data sharing through public-private partnerships. For example, in June 2014, during the World Cup in Rio de Janeiro, the government obtained driver navigation data from Google's Waze app and combined it with information from pedestrians who use the public transportation app Moovit, providing local authorities with valuable real-time information about the transportation network. Previously, the local transportation department had been reliant solely on road cameras and roadway sensor data. Incorporating data from Waze and Moovit allowed local officials to use aggregated mobility data on 110,000 drivers (half a million over the course of the month) and to identify thousands of operational issues ranging from congestion to roadway hazards (Olson, 2014). In exchange for sharing user mobility data with government authorities, Waze asked for transportation network data (e.g., sensor data, construction information, etc.). This is a notable example of how the public and private sector can mutually benefit through data exchange partnerships.

Open Data

Providing open data has allowed local governments and public agencies the ability to offer real-time transportation information to their communities, without the cost or responsibility of developing or maintaining mobile applications themselves. For example, in Chattanooga, a partnership was formed between the Code for America[4] team and the Chattanooga Area Regional Transportation Authority allowing digital public transit schedules to be available to third-party developers on GitHub. Public agencies need to develop acceptable use policies to provide terms and conditions for private sector use of public sector data. In another example, the North American Bikeshare Association recently adopted an open data standard, pledging to make real-time data feeds available in a standardized format so these data can be readily incorporated into smartphone applications. Efforts such as this will improve

[4] Code for America is a non-partisan, non-profit organization whose mission is to address the role of the public and private sectors in their effective use of technology.

transparency and public access to bikesharing data and support the development of integrated software and end user applications. Some guiding principles for open data include:

1) Data Accessibility

   Ensure that data made available are in an open format that can be downloaded, indexed, searchable, and machine-readable to allow automated processing.

2) Open License

   Data are available to the public for use.

3) Data Quality and Timeliness
   - Data are high quality scrubbed for plug-and-play end use by developers without requiring extensive effort to make datasets usable.
   - Data are made available as quickly as possible and frequently enough to remain current and usable.

Once local governments have established open data standards and data become available, the next step is to establish data exchanges to share this information.

Data Exchanges

Public agencies could establish data exchanges to serve as a repository for public and private sector data sets. Public agencies can establish data exchanges by:

1) Maintaining in-house capability through a chief technology officer or chief data officer, for example, to oversee data standards and data exchanges.
2) Establishing Data Standards:
   - Determine the type of data useful for public agency and private sector use both for the planning, design, operation, safety, and maintenance of the transportation network and the development of third-party apps.
   - Determine the format and standards for publishing data sets that are consistent with industry standards, other public entities, and address interoperability issues.
   - Require two-way data sharing, when possible. For example, apps must share self-reported incident data with public agencies in exchange for receiving their data. Develop standards for aggregating these data and disseminating this aggregated data real time.
   - Develop standards for classifying and updating data.
   - Include metadata with key methodological information on how data were collected.

- o Require geocoding location-based data to make such data suitable for mapping functions.
- o Develop standards for data dissemination.

3) Establishing Conditions for Use:
    - o Require transportation service providers and apps to share data as a condition for offering services within a jurisdiction.
    - o Require open access to trip aggregator apps (i.e., trip aggregator apps cannot provide exclusive access to one service provider on its app and exclude another).
    - o Require that data sources filter and scrub their data, according to set standards, prior to uploading to a data exchange.
4) Establishing Data Management Platforms:
    - o Establish standard operating procedures to protect consumer privacy and proprietary data.
    - o Establish user agreements, data upload, data storage, and data delivery (download) capabilities in conjunction with third-party organizations.
    - o Timestamp and archive old data to ensure that historical data are made available on data exchanges.
5) Establishing a Data Dashboard (for internal use):
    - o Public agencies may consider establishing a data dashboard that assists local governments in tracking longitudinal data metrics against a baseline (e.g., modal split, app modal share, etc.).

ENCOURAGING MULTI-MODALITY

Leveraging smartphone applications to encourage multi-modal travel represents a key opportunity for public agencies. Enhancing multi-modal payment interfaces and enabling commuter benefit payment via smartphone apps are two ways public agencies can encourage multi-modal trips.

Enhancing Multi-Modal Payment Mechanisms

With a growing array of private sector trip planning (e.g., ticketing and fare payment apps and integrated solutions), fare payment is becoming increasingly complex for the end user. An end user may be able to plan an entire public transit trip on a single app, but generally these multi-modal connections will require multiple fare payments. Smartphone apps offer an opportunity to integrate fare payment mechanisms into a unified, single process where a user not only uses a single app to plan and execute an entire journey but also a single point-of-sale for the entire trip. Developing a common fare payment platform for a single point-of-sale to cover an entire journey (multiple modes) can make smartphone apps more convenient to use and support multi-modal trip planning, ticketing, and payment.

Expanding Commuter Benefits

Expanding commuter benefits to incentivize multi-modal trips could encourage the use of a broader variety of modes and services. This could be enabled by allowing smartphone apps access to pre-tax commuter accounts (e.g., journeys could be paid for by using pre-tax payroll deductions); employer-provided usage (e.g., mechanisms that allow employers to pay for commute expenses directly to an app service provider); and providing app-based commuter incentives linked to a user's modal choice (e.g., incentives for carpooling or riding public transit, calculated and awarded based on a person's app account).

PROTECTING CONSUMER PRIVACY

Generally, smartphone apps collect a lot of private information from their users. In the transportation context, this can include particularly sensitive information, such as addresses, current location, location history, and financial information (for fare payment). More broadly, transportation apps can trace mobility habits and share a user's location (via third-party APIs). Some users may or may not pay attention to the information usage permissions they grant (via user agreements and app installation processes). Sometimes the data shared and how the data will be used is opaque and confusing for the user. The private sector can aid mobility consumers in making informed decisions about the data they share by ensuring that user agreements are drafted in plain language, comprehensible, and easy to read on mobile devices so that users clearly understand how their personal data may be shared and used.

Developers can help protect consumer privacy by designing apps that do not require full-scale access to user data. This can help mitigate over sharing of consumer data. As a practical matter, developers should generally scrub their data and remove PII from data sets when sharing information with third parties, unless the information included serves a specific mobility function (e.g., sharing data as part of an API for a third-party app). De-linking user information (e.g., names and user identifications) from financial and location data can also help protect from unintentional data sharing and data breaches where de-linking is technically feasible to achieve the app's purpose.

The public and private sector should continually develop (and enhance, as needed) policies that protect user data privacy. In January 2013, a report, "Privacy on The Go: Recommendations for the Mobile Ecosystem" provided high-level recommendations for app developers, app platform providers, mobile ad networks, operating system developers, and mobile carriers (Harris, 2013). The report identified many privacy problems; however, it concluded that more research is needed by governmental agencies on data privacy and data sharing issues.

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