# Real-Time Ridesharing: Exploring the Opportunities and Challenges of Designing a Technology-based Rideshare Trial for the MIT Community

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Submitted to the Department of Urban Studies and Planning and the
Department of Civil and Environmental Engineering
in Partial Fulfillment of the Requirements for the Degrees of

**Master in City Planning**
and
**Master of Science in Transportation**

at the
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June 2010



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**Real-Time Ridesharing: Exploring the Opportunities and Challenges of Designing a Technology-based Rideshare Trial for the MIT Community**

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# Abstract

The potential benefits from increased ridesharing are substantial, and impact a wide range of stakeholders. In a properly applied rideshare scheme, drivers and passengers achieve cost savings, they potentially achieve travel time savings, and they benefit from increased travel options. Employers can reduce expensive parking construction or leasing, and benefit from higher worker productivity. Society benefits from congestion reduction, energy security improvements, greenhouse gas (GHG) emission reductions and increased social equity. Unfortunately, ridesharing's historical success has been rather modest, with a substantial decrease in popularity since the 1970's and participation that remains near an all-time low. Clearly there is a disconnect between the purported benefits and the real or perceived challenges associated with sharing rides. This thesis asks why ridesharing is not more popular than current participation suggests, and what can be done to encourage greater participation going forward?

After a review of past and present rideshare initiatives, it becomes clear that there is no single challenge to be overcome that will increase interest and participation in ridesharing. Rather, the 'rideshare challenge' is a series of economic, behavioral, institutional and technological obstacles to be addressed.

Yet, two opportunities show particular promise at helping overcome these challenges – a focus on large employers, and a technology-based service innovation known as "real-time" ridesharing. Large employers are a unique type of institution that can successfully influence private household travel decisions while simultaneously advancing employer-specific goals and various societal goals. "Real-time" ridesharing extends the range of existing rideshare options available to travelers and it begins to address a number of challenges associated with ridesharing.

To increase rideshare participation going forward, this thesis proposes a detailed design for an employer-based, technology-focused rideshare trial for the Massachusetts Institute of Technology (MIT), supported by a rigorous, Institute-specific analysis of rideshare viability. The trial is designed to be expanded to other institutions in the MIT/Kendall Square area of Cambridge, MA in the future. The analysis suggests that on an ideal day, approximately 65% of consistent, single occupant commuters could share rides, leading to a 19% reduction in Institute-wide, commuting trip VMT. The trial design focuses on the use of technology, incentives and personalized marketing to overcome the 'rideshare challenge' and realize a significant portion of this best case VMT reduction.

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## Acknowledgements

The writing of this thesis, while an individual undertaking, would not have been possible without the ideas, suggestions and support of so many people.

I'd like to thank all of those interviewees that spent countless hours sharing their perspectives on ridesharing with me. Many thanks to Valerie Webb, my rideshare research partner, whose hard work made this thesis that much easier to write.

I am grateful to my review team for their feedback throughout this process. I would like to thank my thesis advisor, John Attanucci, my thesis reader, Professor Joseph Ferreira, and Professor Rabi Mishalani from the Ohio State University for their help framing and guiding this research along.

Special thanks are owed to Marc Oliphant from Virginia Tech and Allen Greenberg from FHWA for acting as sounding boards throughout the creation of this document.

I certainly would not have managed to complete this thesis without the technical support provided by my fellow officemates. Many thanks to Michael Frumin, David Block-Schachter & Tony Laidig for their help.

I am tremendously grateful to Mike & Jenny Messner and the Speedwell Foundation, this research would not have been possible without their generous support and enthusiasm.

Finally, many thanks are owed to my Mom & Dad, for being patient with me and encouraging me to do my best.

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## List of Abbreviations

| | |
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| AASHTO | American Association of State Highway Transportation Officials |
| ACS | American Community Survey |
| API | Application Programming Interface |
| APTA | American Public Transportation Association |
| AVL | Automatic Vehicle Location |
| BART | Bay-Area Rapid Transit |
| CES | Consumer Expenditure Survey |
| DOT | Department of Transportation |
| EIA | Energy Information Administration |
| EPA | Environmental Protection Agency |
| FTA | Federal Transit Administration |
| FOCCS | Flexible Operations Command and Control System |
| FHWA | Federal Highway Administration |
| GHG | Greenhouse Gases |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| GTFS | Google Transit Feed Specification |
| HBW | Home-based-Work |
| HOT | High Occupancy Toll |
| HOV | High Occupancy Vehicle |
| MBTA | Massachusetts Bay Transportation Authority |
| MIT | Massachusetts Institute of Technology |
| MPH | Mile per Hour |
| MPO | Metropolitan Planning Organization |
| MSA | Metropolitan Statistical Area |
| NECA | National Energy Conservation Act |
| NHTS | National Household Travel Survey |
| OPC | Office of the Petroleum Coordinator |
| PAW | Petroleum Administration for War |
| PDA | Personal Digital Assistant |
| PIWC | Petroleum Industry War Council |
| PRTC | Potomac-Rappahanock Transportation Commission |
| SaFIRES | Smart Flex-route Integrated Real-Time Enhancement System |
| SOV | Single Occupant Vehicle |
| TMA | Transportation Management Association |
| TVA | Tennessee Valley Authority |
| VDOT | Virginia Department of Transportation |
| VMT | Vehicle Miles Traveled |
| WSDOT | Washington State Department of Transportation |
| WWII | World War 2 |

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# Chapter 1: Introduction

The purported benefits from increased ridesharing are substantial. A successful rideshare scheme could reduce fuel consumption and emissions, reduce congestion during peak travel periods, reduce parking costs for travelers and employers, and provide a reliable alternate mode for travelers. For commuters, major rideshare benefits include travel time savings, cost savings (namely fuel and parking) and increased mode choice. For employers, reduction in the cost of providing parking and improvements in worker productivity brought about by less stressful commutes are two of the primary benefits. For government, the benefits include congestion reduction, energy security improvements and greenhouse gas (GHG) emission reductions. Ridesharing can also promote greater equity in the transportation sector by ensuring that mobility is maintained for lower income travelers, particularly in light of increased interest in road user fees and high-occupancy toll (HOT) lanes.

Yet, with such a wide range of benefits to so many different stakeholders, why is it that ridesharing is not more popular than current participation suggests, and what can be done to encourage greater rideshare participation going forward? This thesis proposes a three-step approach to answering those questions. First, a thorough review of past and present rideshare initiatives will be used to present a number of rideshare challenges. Second, the opportunities and shortcomings of a promising new rideshare service offering known as “real-time” ridesharing will be discussed. Third, an employer-based, technology-focused rideshare trial will be designed for the Massachusetts Institute of Technology (MIT) and supported by a rigorous, Institute-specific analysis of rideshare potential, or viability.

The first part of this thesis will be retrospective; it will review what we know about the ridesharing population, what the major motivations are to share rides, and what providers of rideshare services believe are the greatest challenges to be overcome. After a thorough review, the ‘rideshare challenge’ will be presented as a series of economic, behavioral, institutional and technological obstacles to be overcome. The second part of this thesis will be forward looking. It will begin with a critical evaluation of an innovative, technology-based service known as “real-time” ridesharing. The thesis will than propose a methodology for measuring rideshare potential and will apply it to two large institutions in Cambridge, MA; the Massachusetts Institute of Technology and the VOLPE Transportation Center. The final chapter synthesizes much of the knowledge contained in this thesis into the design of an employer-based, technology-enabled rideshare trial for MIT that aims to overcome previous challenges and increase future rideshare participation.

## 1.1 Introducing the Economics of Ridesharing

Many would likely agree that the current use of public roadways in the US suffers from a number of economic externalities that lead users to travel more than they otherwise would, due in large part to the under pricing of access to, and use of, roadway infrastructure. Roadway users are making rational decisions in their own self-interest, but in the process they impose a multitude of costs on others including congestion and air pollution. Economically efficient solutions to the problems of congestion and air pollution involve increasing the cost of roadway use and access for a given individual to a level that equals the marginal cost imposed on all other users. This is the theory that underlies the concept of congestion pricing.

Note, however, that the underlying economic conflict with managing congestion pits private citizens attempting to maximize their personal well being vs. society, or the public sector, attempting to maximize societal welfare. In those cases where socially optimal solutions such as congestion pricing are implemented, it is because a single entity, often a public agency, controls the underlying asset and determines how it is used. Compare and contrast this situation to that of ridesharing. Many of the benefits from ridesharing are societal in nature, yet often rely on collective, private action to be achieved. This is a critical difference between ridesharing and other socially desirable actions such as congestion pricing; in the case of ridesharing, there is no single entity that can dictate how private vehicles are used. Rather, it is millions of individual vehicle owners that are each being asked to absorb some additional burden for the benefit of society. It should be noted that it is not only societal benefits that can be gained from ridesharing. Cost savings are a major motivator for many participants, which helps explain why ridesharing remains the second most popular mode of travel for the journey-to-work in the US. Nevertheless, a number of the specific economic, behavioral and institutional challenges with ridesharing can be traced to the fact that (1) the infrastructure (vehicles, in this case) are owned by a large number of private entities with different motivations, and (2) that few institutions have the ability to substantially influence more efficient (higher occupancy) use of these private assets.

## 1.2 The Importance of Large Employers

In the case of ridesharing, large employers can be particularly influential in changing employees travel behavior, more so than public agencies or smaller private firms. Large employers, particularly those in central locations, often have capacity constraints on parking either due to the high cost of provision, or because local and/or state regulations place limits on the number of spaces that can be provided. This often means that large employers are more proactive at encouraging alternate modes of travel for their employees. Further, research suggests that employees are more likely to share rides with someone that they know or have a common social bond with. Family members, co-workers and neighbors are the most common rideshare partners, largely because of a common social connection. Finally, from a matching perspective, the existence of a large employer guarantees that a substantial number of individuals will be traveling to a fixed destination. This changes the typical “many-to-many” rideshare matching relationship to a “many-to-one” relationship, meaning that an individual within a large firm has a higher probability of finding a rideshare partner than someone not affiliated with the firm. Large employers are one of the few institutions that can successfully influence private household travel decisions without unduly burdening individuals.

## 1.3 The Need for Innovative Travel Options

The state of the US surface transportation system suggests that there is a strong need for innovative travel options. Record high gasoline prices in 2007 and 2008 have strained automobile owners budgets and are curtailing mobility. In 2008, annual nationwide VMT decreased for the first time since 1980, and showed the sharpest single year percent decrease since 1960 (US DOT, 2008), due largely to high gasoline prices and the economic downturn. In response to higher fuel prices, travelers shifted to other modes of travel including ridesharing and transit. Ridesharing recorded its first ever measured increase in mode share in 2005 (US Census, 2005), and 2007 transit ridership was the highest its been since 1956 (APTA, 2009a).

Sadly, the record high fuel prices have placed substantial strain on transit agency budgets at the very time that ridership is at its highest. Between mid-2008 and mid-2009, 89% of transit providers in the US were forced to either raise fares or cut service to fend off growing operating deficits, and 47% of agencies resorted to raising fares and cutting service simultaneously (APTA, 2009b). Unfortunately, even with a shift away from automobile travel, congestion on the nation’s roads held almost steady, according to the Texas Transportation Institute. Data from 2007 suggests that per passenger annual delay was only 1.4% lower than a year earlier, costing the American economy $87 Billion in wasted fuel and lost productivity (Schrank & Lomax, 2009).

All of this comes at a time when revenue for transportation has been exhausted and investment needs are expected to increase substantially. The federal Highway Trust Fund has officially run out of money and has received two emergency cash infusions totaling $15 Billion from general tax revenue sources in 2008 and 2009 (AASHTO, 2009b). With discussions of a gas tax increase politically unpalatable for the foreseeable future, the prospect of raising revenue to address the $212 Billion ($166 Billion for highways and bridges, $46 Billion for transit) needed per year, over the next 5 years to address deferred maintenance and new growth is grim (AASHTO, 2009a). The current situation suggests that flexible, low-cost travel options that utilize existing infrastructure are needed.

## 1.4 Research Approach

A variety of complementary approaches were used in this thesis; they can be grouped into four distinct categories. The first category of research was a review of the existing literature on ridesharing and travel behavior. While a rather broad review of past work was undertaken, a strong emphasis was placed on identifying and learning from previous rideshare trials that have been planned and/or conducted. Literature on the history of ridesharing, and rideshare survey data was also reviewed. Some effort was placed on describing the 'state-of-the-practice'; identifying current rideshare service providers and comparing the type or services and technologies they are using. Finally, while there exists relatively little quantitative, time-series data on ridesharing, statistics and trends have been summarized to the degree possible.

The second category of research involved a series of interviews with rideshare stakeholders, mainly innovative providers, government agencies, and several large employers. The interviews served a number of purposes including understanding how different stakeholder groups perceive the rideshare challenge, understanding different approaches to dealing with the outlined challenges and soliciting ideas on larger changes that may be needed to significantly increase rideshare participation in the future.

The third category of research involved the development of a model using commuter survey data from the Massachusetts Institute of Technology and the VOLPE Transportation Center. One of the major gaps identified in the academic literature was a lack of understanding of the size of the rideshare "market". The model aims to identify the share of the MIT and VOLPE communities that could realistically rideshare on a given day, based strictly on the physical characteristics of the commuting trip (vehicle availability, origin, destination, route and arrival/departure time from campus). This analysis is unique in that it provides an estimate of rideshare potential at based solely on the physical characteristics of the trip, but compares the model results against actual observed behavior. In this sense, the model provides an estimate of the relative importance of behavioral considerations vs. physical characteristics of the trip.

The fourth and final category of research was a synthesis of the results of the first three categories of investigation. Rather than simply summarizing the findings of this research, an effort was made to advance the state-of-the-practice by synthesizing the findings into the design of a rideshare trial for the MIT community. The trial design attempts to be comprehensive and includes roles for different stakeholder groups, data collection considerations, technologies to be used and customized incentive packages.

## 1.5 Thesis Organization

In Chapter 2, a lengthy background on ridesharing is presented including definitions, history and current & historical trends. The term ridesharing is defined and compared to other forms of shared transport. The history of ridesharing in the US is presented, focusing on the four periods of high rideshare participation. The historical account is supplemented with nationwide statistics and trends in ridesharing.

Whereas the second part of Chapter 2 focused on aggregate, historical statistics of rideshare participation, Chapter 3 focuses more heavily on disaggregate, behavior-focused literature. Special emphasis is placed on summarizing the results of previous technology-enabled rideshare trials. A review of evidence on rideshare motivations, the value of incentives and the importance of marketing and promotion of rideshare initiatives is also undertaken.

Chapter 4 summarizes the main points from the interviews undertaken with service providers, government agencies and other organizations. In addition to outlining rideshare challenges, some of the approaches that rideshare providers are using to make rideshare more appealing are also discussed. To the degree possible, common observations and challenges are summarized.

Chapter 5 summarizes the bulk of the first half of the thesis by presenting the 'rideshare challenge'. A variety of economic, behavioral, institutional and technological challenges are discussed. While certain challenges are likely to be more critical than others, the focus of this chapter is on presenting the variety of ways that one can view the rideshare challenge.

Chapter 6 begins to describe the benefits and drawbacks of real-time ridesharing. Real-Time ridesharing reduces a number of the market frictions associated with ridesharing, but it does involve trade-offs for drivers and passengers. While real-time ridesharing is seen as a positive and necessary step towards improving rideshare participation, this chapter will try to explain why this innovation alone is not sufficient to induce substantial mode shift.

Chapter 7 presents the results from a model constructed to estimate the size of the ridesharing market at MIT. The modeled results are compared to observed rideshare behavior in an attempt to discern what the relative importance of physical trip characteristics are as compared to human preferences. In an effort to demonstrate the potential for ridesharing beyond the MIT community, the model is applied to another large employer in the Kendall Square area, the VOLPE Transportation Center.

Chapter 8 is the capstone of this thesis. A rideshare trial for the MIT Community is designed, with particular emphasis placed on the incentives offered, customized marketing, the use of innovative rideshare services and the particular roles for different stakeholders. Additional considerations for other employers are presented.

Chapter 9 summarizes the research undertaken and recommends additional topics for future research.

# Chapter 2: Background on Ridesharing – Definitions, History & Statistics

Ridesharing, or carpooling, is a concept that just about anyone can identify. Nearly all of us have spent time in a vehicle with someone else, either a family member, friend or co-worker. Yet beyond the simple mental image of two or three people traveling in a vehicle, little thought is given to more detailed questions about ridesharing. How does one formally define ridesharing? Should taxis be considered a type of ridesharing? When and where has ridesharing been a particularly attractive mode of transport? What are the predominant characteristics of the population that share rides? This chapter provides a background on ridesharing, beginning with a review of several rideshare definitions. After defining ridesharing and an innovative sub-type of ridesharing called "real-time" ridesharing, the chapter will outline its history and present a variety of statistics on ridesharing and what we know about it as a mode of travel.

## 2.1 Existing Rideshare Definitions

One of the major challenges in establishing a consistent mental image of ridesharing is the lack of a widespread, common definition of the phenomenon. The US Department of Transportation has no official definition of ridesharing, or of carpooling. Instead, the states have been left to establish their own definitions, which they appear to have done largely as a method of distinguishing between carpools and commercial transport services operating for profit, such as taxi services. The State of Virginia has a rather straightforward definition of ridesharing: "the transportation of persons in a motor vehicle when such transportation is incidental to the principal purpose of the driver, which is to reach a destination and not to transport persons for profit" (Code of Virginia, 1989). Virginia has clearly tried to identify ridesharing on the basis of driver trip purpose and profit-making potential. The State of Colorado had one of the more complex definitions of ridesharing before it was repealed in 2003. It defined ridesharing as "the vehicular transportation of passengers traveling together primarily to and from such passengers' places of business or work or traveling together on a regularly scheduled basis with a commonality of purpose (shopping, health, educational, religious, athletic, or sports facilities), if the vehicle used in such transportation is not operated for profit by an entity primarily engaged in the transportation business and if no charge is made other than that reasonably calculated to recover the direct and indirect costs of the 'ridesharing arrangement, including, but not limited to, a reasonable incentive to maximize occupancy of the vehicle… The term includes 'ridesharing arrangements' commonly known as carpools and vanpools; however, this term does not include school transportation vehicles operated by elementary and secondary schools when they are operated for the transportation of children to or from school or on school-related events" (Colorado Revised Statutes, 2002). This definition clearly tried to define ridesharing on the basis of passenger trip purpose, frequency of trip, commonality of origin & destination, and profit motive. The next section will identify three key characteristics of ridesharing and will categorize different types of shared vehicle transportation.

## 2.2 Categorizing Shared Vehicle Transportation

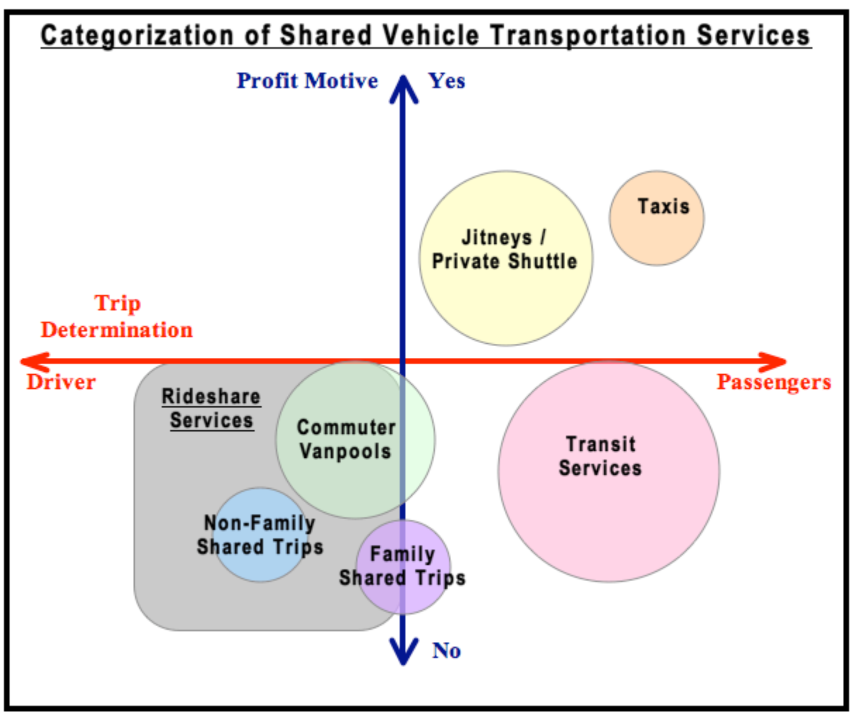
A common point of confusion in defining shared vehicle transportation is how to distinguish between ridesharing, carpooling, public transit and taxi services. For the purposes of this thesis, the term ridesharing is synonymous with carpooling. At a basic level, both refer to the use of a private, individually owned vehicle to transport multiple passengers. While the use of the term carpooling has a longer history, it has recently become conflated with the term carsharing, an innovative transportation service where multiple people share access to a common pool of vehicles that are available for short-term use. In an effort to distinguish between the shared use of a vehicle (carshare) and shared vehicle trips (carpool/rideshare), the older, less-precise carpool term will be avoided to the degree possible. References to carpooling statistics, particularly in this chapter and in Chapter 3, will continue to be used, as this is the term that US DOT and the Census Bureau continue to use.

The distinction between ridesharing and public transit is not always clear. An argument could be made that the major differences between the two are the capacity of the vehicle, and the participant that determines whether a trip is undertaken (driver or passenger). The vehicle capacity distinction should be obvious; transit frequently (but not always) operates larger vehicles such as trains and buses whereas ridesharing often occurs in smaller vehicles such as cars and passenger vans. While transit's primary purpose is to transport multiple passengers to a destination, ridesharing differs in that it generally occurs when the driver is planning on undertaking a trip and seeks out a passenger who is willing to share the ride. In other words, transit trips operate with an implied understanding that service is based on passenger demand and if sufficient communal demand does not exist (such as on weekends) the driver will not undertake the trip (service will be reduced). Ridesharing, on the other hand, is better described as a trip that the driver intends on taking whether or not they can find an appropriate passenger to share the ride with.

The "vehicle capacity" and "trip determined by driver or passenger" characteristics alone are not entirely satisfying. If one considers taxi trips, they take place in small vehicles where the passenger dictates the purpose of the trip. Essentially, taxi trips are neither a form of transit or ridesharing according to the distinction laid out in the previous paragraph. A further refinement is the absence of a profit-seeking motive on the part of the driver in rideshare arrangements. Whereas taxi drivers are profit seeking in their carriage of passengers, rideshare drivers in most cases seek only to share the costs of transport. In fact, in some jurisdictions such as Colorado, government legislation mandates that financial transactions only reflect the sharing of trip costs.

The three characteristics of ridesharing (smaller vehicle capacities, the trip is determined by the driver's needs and the lack of profit motive) allows for the categorization of most forms of shared vehicle transportation. Figure 2.1 below presents a categorization of shared vehicle transportation where driver/passenger trip determination is on the horizontal axis, profit motive is on the vertical axis and the size of the circles represents the relative capacity of the vehicles used. For the purposes of this thesis, commuter vanpools, non-family shared trips, and certain types of family-based shared trips will be considered ridesharing.

**Figure 2.1: Categorization of Shared Vehicle Transportation Services**




As previously described, taxis operate in smaller vehicles catering specifically to passenger trip needs and seek a profit while doing so.

Jitneys / Private Shuttles are a unique type of service. They are privately operated vehicles, generally have higher passenger capacities (buses or vans), and often travel an established route with some deviations. They are profit-seeking enterprises, often organized as owner-operator businesses, or consortiums of owners with a few vehicles each. Because of their profit motive, jitneys seek to maximize the number of passengers they carry and will often seek out corridors that are underserved by other modes of transportation. In the US, several municipalities do allow private shuttle buses and jitneys to operate (with insurance and safety verification) but in most jurisdictions they are illegal. New York City and Miami in particular, have a thriving jitney culture, both legal and illegal (Cervero, 1997).

Transit services operate using vehicles of a variety of sizes, but often in larger vehicles. They operate based on passenger trip needs. In some parts of the world, transit operates at a profit, but in North America this is not the case.

Vanpools operate in small to intermediate sized vehicles. The distinction between commuter vanpools and those such as airport shuttles that operate using vans is worth discussing. While commuter vanpools rely on a driver (or multiple drivers) that agree to operate the van on a daily basis, airport vanpools only operate when passenger demand exists. Further, airport vans are profit seeking whereas commuter vanpools do not turn a profit. In instances where commuter vanpools claim a profit has been made, it is often because of financial transfers or subsidies from employers or a public agency. In terms of characteristics, airport vanpools are much more similar to jitneys and private shuttles than they are to commuter vanpools.

Family ridesharing should be a relatively intuitive form of shared transport. Related individuals will share a trip in low capacity, family-owned vehicles. There is no profit motive whatsoever. Either the driver or the passenger may determine the purpose of the trip, which creates a particular difficulty in the categorization of family-based shared rides. In cases where the driver undertakes a trip (travel to work, for example) and drops off a child at school, or a partner at their place of work before continuing to their destination, than the trip can safely be described as ridesharing, as the purpose of the trip was mainly to meet the driver's needs. In cases where the driver drops off a passenger but then returns to their original starting point, than the primary purpose of the trip was really to serve the travel needs of the passenger. These types of trip are better defined as small vehicle transit trips.

Non-family ridesharing should also be relatively intuitive. In these cases, friends, co-workers, neighbors or unrelated individuals will travel in a small capacity vehicle. Once again, no profit motive exists, although sharing of travel costs may be expected. In most cases, the driver has an established purpose for undertaking the trip and will take a passenger when it is convenient to do so.

This is an idealized categorization of shared transport services. Note that these service types do not always fit neatly into the described categories. As the discussion of vanpools and family rideshare trips have demonstrated, some of these shared transport services may take on the characteristics of multiple service types. Nevertheless, the categorization should be useful in distinguishing between the many different types of shared transport.

## 2.3 Defining Ridesharing

Based on the shared transport characteristics described above, this author's proposed definition of ridesharing is: "the transportation of two or more individuals in a motor vehicle with a capacity not exceeding 15 passengers, when such transportation is incidental to the principal purpose of the driver, which is to reach a destination, and when such transportation does not seek to transport persons for profit." This definition incorporates the three characteristics described earlier in this chapter. Further, it addresses the issue of "unsustainable ridesharing", whereby an initial rideshare journey results in an SOV return journey because the trip is undertaken to meet the needs of the passenger. As was described in the discussion of family-based shared rides in the previous section, "unsustainable ridesharing" is not uncommon in school trips, where parents will drive their child to school but will return home alone. Since the definition states that the ***driver's*** principal purpose determines the trip being undertaken, multi-occupant trips catering to the passenger's trip purpose should not count as ridesharing according to a strict interpretation of this definition.

This definition does create some important measurement limitations. The inclusion of driver trip purpose in the definition makes the identification of rideshare trips much more difficult, and certainly more onerous than simply counting vehicles with at least two occupants. Yet, the inclusion of driver trip purpose is a very important addition to the definition of ridesharing, particularly from a policy standpoint. Ridesharing is often described as a sustainable alternative to traveling alone and is encouraged by different levels of government. Clearly the sustainability of this mode rests on the ability to combine two unique trips that would have otherwise occurred separately. When travel demand leads to the creation of a new vehicle-based trip, part of which is an SOV trip, it undermines the message that ridesharing is a sustainable mode. Ideally, the measurement of rideshare participation should differentiate between multi-occupant trips undertaken based on driver vs. passenger trip purpose, and only assign credit to those where the driver's trip purpose dictated travel. To operationalize this definition, more precise travel diaries and surveys would need to be administered specifically asking participants what the purpose of their trip was, and seeking more detailed information on trip-chaining tendencies.

For the purposes of this thesis, the term ridesharing will not always be used as strictly as the proposed definition above. When statistics from government sources or research reports are cited, the term 'ridesharing' will generally refer to the less specific definition of vehicle trips with more than one occupant, but not vanpools or transit trips. In general, references to 'ridesharing' in the remaining sections of this chapter, and Chapters 3, 4 & 7 will use the less specific definition. Where normative statements are made, largely in Chapters 5, 6, 8 & 9 the term ridesharing will refer to the stricter definition that includes presumed knowledge of trip purpose.

## 2.4 Introducing "Real-Time Ridesharing"

In recent years, an innovative rideshare service offering known as "real-time" ridesharing, "dynamic" ridesharing or "technology-enabled" ridesharing has emerged. Traditionally, rideshare arrangements between two or more unrelated individuals for commuting purposes have been relatively inflexible, long-term arrangements. Partners will establish reasonably fixed departure time schedules and driving responsibilities. The complexity of work and social schedules and the perceived increase in vehicle trip complexity, such as trip chaining, has made this type of commuting arrangement much less desirable. "Real-time" ridesharing attempts to provide added flexibility to rideshare arrangements by allowing drivers and passengers to partake in occasional shared rides when their schedules allow it.

Imagine you find yourself at the office late one evening. You could walk the ¼ mile to the bus stop, but you're not looking forward to the potential wait once you get there. Instead, you pull out your smart phone, log into your preferred 'real-time' ridesharing service and post your desire for a ride home in the next 45 minutes. If you do not hear back in 30 minutes, you'll start walking to the bus stop. The Internet-connected, GPS-enabled device automatically detects your current location, takes the home location that you have programmed in previously and searches the database for drivers traveling a similar route and willing to pick up passengers. Twenty minutes later, you receive a text message or instant message saying a driver will be passing by your location in 5 minutes, is willing to share a ride with you, but will have to leave you a 5 blocks from your house. The cost of the trip is $3. If you are willing to accept the ride, you can tap “yes” on the screen or press the “1” key, to decline the offer, tap “no” or press “2”. You accept the offer and start packing your briefcase. Your acceptance triggers a text/instant message back to the driver confirming the ride and where they should pick you up. The proponents of “real-time” ridesharing cite flexibility and convenience as the major benefits of this type of service.

“Real-time” or “dynamic” ridesharing has been defined in a variety of ways. One of the first formal definitions proposed for “real-time” ridesharing was developed in preparation for a trial in Sacramento, CA in 1994. The research team defined “real-time” ridesharing as “a one-time rideshare match obtained for a one-way trip either the same day or the evening before” (Kowshik et al., 1996). Several years later, researchers developing a similar trial in Seattle proposed that “dynamic ridesharing” be defined as “two or more people sharing a single trip, without regard to previous arrangements or history among the individuals involved…a dynamic ridesharing system must be able to match random trip requests at any time.” (Dailey et al., 1997). A more recent definition proposed by ‘dynamicridesharing.org’ suggests that “dynamic ridesharing” is “a system that facilitates the ability of drivers and passengers to make one-time ride matches close to their departure time, with sufficient convenience and flexibility to be used on a daily basis” (Kirshner, 2008). Note that all three of the definitions emphasize the occasional nature of these arrangements, using the term “one-time” trips. The other main characteristic of all three of these definitions is the amount of advanced notice required for the arrangement of trips with the Sacramento definition recommending the “same day or the evening before” a trip, the Seattle definition recommending “at any time”, and the ‘dynamicridesharing.org’ definition recommending “close to [participants] departure time”. In general, “real-time” ridesharing implies that little advanced notice is needed when attempting to establish a shared trip.

For the purposes of this thesis, “real-time” ridesharing will be defined as “a single, or recurring rideshare trip with no fixed schedule, organized on a one-time basis, with matching of participants occurring as little as a few minutes before departure or as far in advance as the evening before a trip is scheduled to take place”. In addition to the proposed definition, the use of the term “real-time” ridesharing may refer to the package of technologies and features that are typically used to enable this type of service.

Many of the "real-time" services rely on a similar set of technologies and share similar features. The underlying technological requirements include:

(1) Smart Phones – Many of the services rely on the rapid proliferation of smart phones in the market place. The firms developing the underlying software for "real-time" ridesharing have focused their efforts on platforms with easy-to-use, attractive user interfaces such as Apple's iPhone software and Google's Android platform.

(2) Constant Internet Connection – The need to communicate ride requests and accept offers on short notice requires that one be constantly connected to the Internet. Many smart phones are now offering (or require) unlimited data access with new smart phone contracts.

(3) GPS Functionality – The use of Global Positioning System (GPS) functionality has been incorporated into many applications so that they become "location aware". In other words, participants seeking a ride do not need to key in their current location, because the GPS built into their smart phone knows where they are located and communicates this information automatically when trips are logged. This is often marketed as a time saving feature.

(4) Ride Matching Algorithm – All of the underlying systems use some form of algorithm to match riders and passengers. Some of the algorithms do so based only on origin and destination, while some of the newer algorithms match drivers and passengers based on the commonality of their route.

While not all of the following features will be found in "real-time" rideshare services, many providers have incorporated some of them:

(1) Stored User Profiles – Nearly all of the software systems allow users to create and save information profiles. Personal information such as name, employer, home and work locations, popular trips with the user's preferred route, and a photo are common. Some systems require a photo of the driver's vehicle and license number be provided. Stored profiles require more participant time on the front end, but make future ride requests much less time consuming.

(2) Social Network Integration – Because of the propensity of individuals to share rides with people they know or share common characteristics with, many providers have linked their services to existing social networks in an effort to improve successful matching. For some, this has meant incorporating their services with online networks such as 'Facebook'. In these cases, only friends within a given individual's immediate Facebook network will be considered when searching for ride matches. For other providers, 'social network

integration' has focused on offering services to a specific organization or institution. In these cases, only co-workers at the same organization are considered as potential partners.

(3) Participant Evaluation – "Real-time" services may allow participants to rate each other, much like the online auction service 'eBay'. After a ride has been completed successfully, both the passenger and driver are asked to rate each other. The idea behind this feature is that it allows future users to evaluate potential partners quickly, based on others past experiences. The theory is that those with higher ratings are likely to be preferable shared ride partners.

(4) Automated Financial Transactions – Several "real-time" services allow for financial transactions between participants. Some allow participants to name their own price, while others recommend a value based on standard IRS vehicle cost estimates. Some providers facilitate automatic transactions through the use of online payment systems such as PayPal. Other providers simply calculate the recommended shared cost and allow drivers and passengers to negotiate and agree on a final amount.

(5) Incentives / Loyalty Rewards Linked to Participation – "Real-time" providers may offer incentives or loyalty rewards based on a given individual's level of participation, much like airline loyalty programs. Those that participate more frequently earn more points or rewards. Providers hope that by providing incentives, existing participants will be encouraged to post rides more frequently, and new participants will be encouraged to join their service.

Further discussion of the benefits and challenges associated with "real-time" rideshare arrangements will be discussed in Chapter 6.

## 2.5 The History of Ridesharing in the US

The history of ridesharing in the US has not been well documented as a single, comprehensive story. Although there are likely several reasons for this, difficulties identifying rideshare trips, and the near lack of financial transactions in rideshare arrangements are two possible, related explanations. This section will briefly summarize the history of ridesharing in the US, focusing heavily on four distinct periods when ridesharing was successful.

### 2.5.1 Difficulties Identifying & Measuring Rideshare Trips

The difficulties identifying and measuring rideshare trips have made it difficult to assemble a full chronological history of this mode of travel. Until the 1970 Census, ridesharing was not even recognized as a mode of travel by the government and as such, formal statistics were not compiled prior to that time.

Further, ridesharing can have varied characteristics depending on how the service has been setup. Some services are longer distance vanpools to central business districts or airports, while others resemble shared-taxis. Some are nearly indistinguishable from ordinary vehicle travel. While this flexibility in service design allows rideshare services to meet differing transport needs in different markets, it makes it much more difficult to establish a simple definition of ridesharing and certainly makes the identification of ridesharing trips difficult. Further, the lack of financial transactions in rideshare arrangements is likely the single largest reason for the lack of participation measurement. To measure automobile use, one can examine gasoline sales. Transit ridership can be reasonably measured through the counting of fare box revenue or transit pass sales. Ridesharing, with nearly no formal financial transactions, is not easy to measure and relies on periodic surveys for estimates of participation.

### 2.5.2 Period #1 - The Jitney Craze (1914-1918)

The first historical incidence of ridesharing success was the tremendously popular yet short lived "Jitney Craze" beginning in 1914. In 1908, the Ford Motor Co. began offering the Model T, the first mass-produced automobile that was affordable to the average "successful" person. The vehicle's popularity soared; in 1908 only 5,896 Model T's were sold but by 1916 sales had soared to 377,036 nationwide (Hodges, 2006). With the increasing penetration of the relatively affordable automobile, streetcars faced their first real competition in the urban transport market. In the summer of 1914, the US economy fell into recession with the outbreak of WWI and some entrepreneurial vehicle owners in Los Angeles began to pickup streetcar passengers in exchange for a 'jitney' (the five cent streetcar fare). The jitney idea spread incredibly rapidly; by December 1914 (merely 6 months after the idea was believed to have been conceived) Los Angeles had issued 1,520 chauffeur licenses for jitney operation (Eckert & Hilton, 1972). In San Francisco, jitneys first appeared in 1914 and were first used to transport workers and attendees to the 1914-1915 Panama-Pacific International Exposition. By 1915, over 1,400 jitneys were operating in San Francisco (Cervero, 1997). With the first jitney's beginning service in Portland, ME in March 1915, the jitney craze had spread from west to east in nine months (Eckert & Hilton, 1972).

Many of the original jitneys operated on well-known streetcar lines and effectively survived by siphoning off streetcar passengers. From the passenger's perspective, the jitneys offered service improvements over the streetcar. Jitney's often operated at speeds 1.5 to 2 times faster than streetcars (Eckert & Hilton, 1972) and could occasionally be convinced to deviate from main routes for drop-offs closer to passenger destinations. For passengers, the ability to choose between two service offerings for the same price was also an attractive service feature. While the reliability of jitney service was sometimes questionable (many only ran during peak periods, few ran during bad weather), passengers had a second option in the form of the streetcar. Travel time savings, route flexibility and transport mode choice were the major value propositions for passengers.

Jitney use was not without tradeoffs. Jitney drivers were known to drive aggressively and accidents were frequent. With passengers standing on the back of vehicles and on the running boards, serious injuries did occur. The transport of female passengers raised concerns in some social circles (Hodges, 2006).

An underlying question that remains a topic of debate is whether jitneys constituted a form of ridesharing or unregulated taxi service. To properly answer this question, the impetus for offering rides should be considered. Given the downturn in the economy, stories of unemployed persons purchasing a vehicle and becoming a jitney operator have been cited in the literature (Eckert & Hilton, 1972, Hodges, 2006). In these cases, jitney service could best be characterized as unregulated taxi service, as drivers were operating the vehicle for the express purpose of providing service to others. In other cases, jitney service seemed to be a method of offsetting the costs of private vehicle ownership for trips that were already going to take place. In a survey in Houston, TX on February 2, 1915, of the 714 active jitneys that day, 442 (62%) made only one or two round-trips, suggesting they might be operating as a jitney during their commute to and from work (Hodges, 2006). In these cases, the primary purpose of the trip was likely commuting; providing service to others was secondary. Any additional revenue generated simply offset the cost of vehicle ownership. In these cases, the generation of revenue was not the main purpose for operating the vehicle, so it could be argued that the service was a form of ridesharing.

The downfall of the jitneys was nearly as rapid as their rise. By early 1915, concerns over safety and liability were being reported in the popular press (New York Times, 1915). Streetcar interests and local governments were eager to stop jitney operations to limit losses in revenue. Streetcar operators were losing paying customers to jitneys, and local governments often taxed streetcar operators a percentage of revenue that they earned, so they were losing tax income as well (Eckert & Hilton, 1972). Many local governments implemented license requirements for jitneys, but the regulation with the largest impact was the imposition of liability bonds. Before operating, jitney drivers were forced to post $1,000 to $10,000 in liability insurance. The licensing and liability regulations added annual costs of approximately $150 to $300, or 25-50% of annual earnings for full-time jitney operators. By July 1915, twenty-seven localities had implemented liability regulations (Eckert & Hilton, 1972). It was estimated that of the 62,000 jitneys in operation in 1915, only 39,000 were still in operation by January 1916 and fewer than 6,000 by October 1918 (Eckert & Hilton, 1972).

There are several important reflections to be drawn from the "Jitney Craze" period. First, the original impetus for picking up passengers appears to have been due to the downturn in the economy. For those that already owned a vehicle, the offering of a ride was presumably to offset operating and ownership costs. For those that began offering jitney services during the period, many had been unemployed and saw operating a jitney as an employment opportunity. In either case, personal finance issues appear to have been a factor. Second, liability and safety were two of the major concerns with jitney service. These same issues remain major concerns with ridesharing today. Third, jitney service provision did not appear to be driven in any major way by resource constraints or environmental benefits, it was largely due to gaps in service quality and economic factors.

### 2.5.3 Period #2 – World War II (1941-1945)

The second major period of rideshare participation, and the period most likely to be identified as the first instance of traditional carpooling, was during World War II (WWII). In a reversal from the jitney era, government encouraged ridesharing heavily during WWII as a method of conserving resources for the war effort. This period of rideshare promotion was exceptionally unique in that it entailed an extensive and cooperative effort between the federal government and American oil companies.

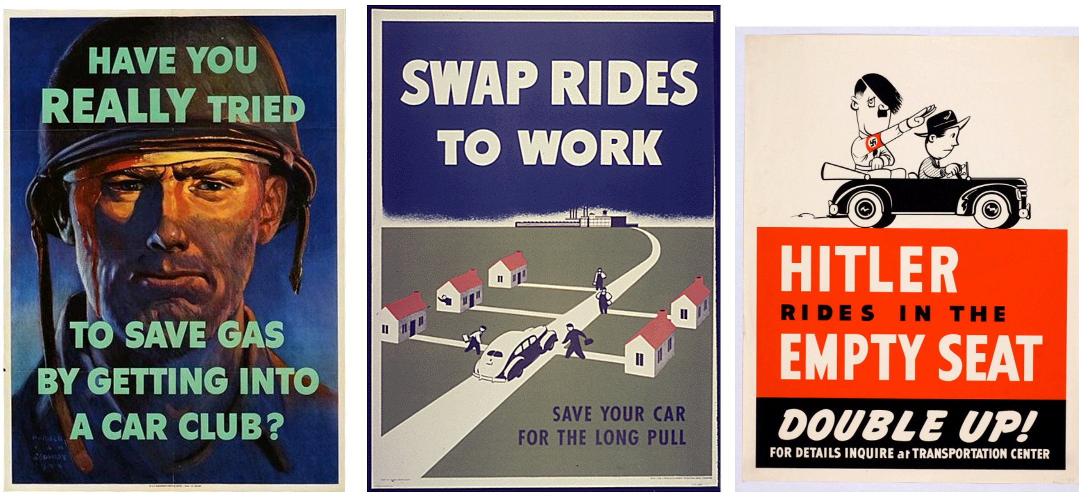
European involvement in WWII began in 1939 but US involvement did not get underway until late-1941 and early-1942. Nevertheless, the federal government had begun making preparations for war much earlier. In May 1941, President Roosevelt established the Office of the Petroleum Coordinator (OPC) (US PAW, 1946). OPC was created to coordinate and centralize all government activities related to petroleum use. The Office was unique in that it relied heavily on industry committees to make recommendations to government; government initiated very few regulations (US PAW, 1946). This structure was chosen specifically because it encouraged all oil industry participants to cooperate amongst themselves, and it was felt that a more cooperative relationship with industry would lead to a greater overall level of voluntary effort.

By July 1941, one of OPC's industry committees organized the first known petroleum conservation effort in the US. The campaign was launched on the East Coast with a $250,000 advertisement budget funded entirely by industry asking the motoring public to use 30% less gasoline (US PAW, 1946). Recommended actions included lowering drive speeds, proper care of tires and the sharing of rides. By the industry's own admission, the effort was not terribly successful. A lack of public appreciation of the need to conserve fuel was cited as the leading challenge to be overcome; "this first drive to emphasize to the American people the necessity of gasoline conservation served one important purpose: it showed industry itself the magnitude of the task, and the growing need for a long-range, sustained program of public education" (US PAW, 1946).

In November 1941, industry created their official council that would interact with the federal government. The Petroleum Industry War Council (PIWC, originally named the Petroleum Industry Council for National Defense), a group that consisted entirely of petroleum industry representatives, was the entity that would ultimately design and fund all petroleum conservation activities during WWII (US PAW, 1946). In an odd twist of irony, PIWC held their first committee meeting on Dec. 8, 1941, one day after the attack on Pearl Harbor and the exact day that President Roosevelt signed the declaration of war against Japan. By February 1942, PIWC had established their Subcommittee on Products Conservation (under the Marketing Committee) and had completed the design of their nationwide conservation program by month's end (US PAW, 1946). After a year and a half of effort, the Subcommittee was discharged in September 1943 and replaced by the higher-level Products Conservation Committee, suggesting the growing importance of oil conservation. This structure remained until the end of WWII. The Products Conservation committee's programs had three main goals; (a) to provide the public with facts so that everyone might better understand the need for rationing, (b) to obtain better compliance with rationing programs, and (c) to bring about greater conservation of gasoline through car sharing [carpooling] and other measures (US PAW, 1946).

The Products Conservation committee was made up largely of advertising specialists. The bulk of the rideshare initiative (and all conservation initiatives during the War) focused on catchy slogans, posters and newspaper advertisements. While the PIWC spent considerable time developing some of the most recognized posters during WWII, they themselves did not publish them. OPC worked collaboratively with various government agencies including the Office of War Transportation, the Office of Price Administration and the Office of War Administration to distribute the ads that they created (US PAW, 1946). All advertisements were released to the public through a government agency. It is once again worth noting that the petroleum industry volunteered their time and resources to this effort with little financial support from government. At the end of the War, it was estimated that the Products Conservation committees had expended $8M. in private funding to support conservation efforts alone (US PAW, 1946).

**Figure 2.2: WWII Carpool Posters**




Sources: US Office of Price Administration, 1944 & US National Archives and Records Administration, n.d.


Sources: US National Archives and Records Administration, n.d.

While there is plenty of evidence of rideshare promotion during WWII, no information could be found on how successful the initiatives actually were. Some statistics exist on the number of newspaper advertisements placed and the estimated readership reached; however, little appears to be known about the actual level of ridesharing that took place during WWII. As discussed in the introduction to this section, part of the reason may be the lack of a financial transaction when sharing rides. Total auto use and transit ridership can be reasonably measured using financial transaction data, but rideshare participation cannot.

As with the "Jitney Era", there are some important reflections to be drawn from the rideshare experience during WWII. In contrast to the "Jitney Era", the main force behind ridesharing during WWII was government-mandated resource constraints (gasoline and rubber) rather than a market response to an economic downturn or a gap in transit service quality. Further, marketers during WWII understood that by appealing to patriotism they could encourage behavior change. There appears to have been a sincere belief that those remaining in the U.S. should make an effort to support their countrymen overseas by reducing their consumption and by making a behavioral change. Third, and perhaps most importantly, was the fact that the promotion of ridesharing during WWII was a large cooperative effort between the U.S. federal government and private industry. It is clear that interests of national importance took precedence over corporate interests during this time period, however, in the absence of a national emergency or compelling long-term threat, it is not likely that this sort of public-private relationship between government and the petroleum industry could be recreated today.

### 2.5.4 Period #3 – The 1970's Energy Crises

The third period of interest and participation in ridesharing was during the energy crises of the 1970's. Interest in ridesharing picked up substantially with the Arab Oil Embargo in the fall of 1973. Throughout the fall and early winter of 1973, President Nixon's administration realized that action would need to be taken to reduce petroleum consumption. In January 1974, Nixon signed the Emergency Highway Energy Conservation Act, which mandated maximum speed limits of 55 MPH on public highways (Woolley & Peters, [2]). The Act was also the first instance where the US federal government began providing funding for rideshare initiatives. For the first time, states were allowed to spend their highway funds on rideshare demonstration projects (Woolley & Peters, [2]). The 1978 Surface Transportation Assistance Act would eventually make funding for rideshare initiatives permanent (US EPA, 1998).

It was during this initial energy crisis that states began experimenting with High Occupancy Vehicle (HOV) lanes. The Shirley Memorial Highway in Northern Virginia had opened as a dedicated busway in the center of the highway in 1969 becoming the first highway in the nation to provide dedicated infrastructure for High Occupancy Vehicles (Kozel, 2002). Beginning in December of 1973, vehicles with four or more passengers were also allowed to use the busway. HOV lane construction proceeded slowly through the 1970's, with interest increasing in the mid-1980's. While the number of required occupants was eventually decreased to three, the Shirley Highway remains one of the most heavily used HOV corridors in the nation today (Kozel, 2002).

The early 1970's marked another first for ridesharing; it was the first time that it was recommended as a tool to mitigate air quality problems (Horowitz, 1976). The 1970 Clean Air Act Amendments established the National Ambient Air Quality Standards and gave the Environmental Protection Agency (EPA) substantial authority to regulate air quality attainment (US EPA, 2008). After initially rejecting the State of California's 'transportation control plan' to meet Clean Air Act requirements in the Los Angeles basin in mid-1972, the EPA issued its own draft plan in late-1972 (Bland, 1976). The initial plan was met with substantial backlash, particularly a provision that would reduce gasoline consumption during the high-smog summer months by an incredible 86% through an aggressive gasoline rationing system. After public consultations, a much more moderate final control plan was issued in 1973. One of the main provisions of the final plan was a two-phase conversion of 184 miles of freeway and arterial roadway lanes to bus/carpool lanes and the development of a regional computerized carpool matching system (Bland, 1976). Phase One was to be completed by May 1974 and Phase Two by May 1976. By the 1976 Phase Two deadline, not a single lane-mile of roadway had been converted for high occupancy vehicle traffic (the El Monte Busway was opened in 1973 and allowed HOV 3+ in 1976; however, it was designed and operating as a high occupancy vehicle facility prior to EPA's final control plan and therefore did not count as a conversion) (Bland, 1976). In fact, the next HOV project in LA County would not be constructed until 1985 and by 1993 there was still only 58 miles of HOV lanes countywide (LA MTA, 2009).

The post-1973/74 Oil Embargo period was a time of great interest in ridesharing. With the funding of rideshare demonstration projects in 1974, academic study of ridesharing and of the results of the rideshare demonstration projects began in earnest. The post-73/74 period also saw the creation of the nation's first metropolitan rideshare agencies (US EPA, 1998). At the outset, these organizations relied largely on marketing campaigns encouraging ridesharing, largely disseminated through roadside signs and public service messages. As research into ridesharing progressed, the importance of employer-based initiatives became better understood and many agencies began to work more closely with large employers (US EPA, 1998).

By the late-1970's, President Carter proposed multiple initiatives to further encourage ridesharing. In 1979, he appointed the National Task Force on Ridesharing to "expand ridesharing programs through direct encouragement and assistance, and create a continuing dialogue among all parties involved in managing ridesharing programs and/or incentive programs" (Downs, 1980, Woolley & Peters, [1]). His administration also understood the negative effect of parking subsidies on rideshare participation. In 1979, his administration tried to amend the National Energy Conservation Act (NECA) to eliminate subsidized parking for federal employees. The bill faced strong opposition from federal employees and was never passed (S. 930, 1979). In 1980, a bill was even introduced which sought to create a National Office of Ridesharing. As with the NECA amendment, this bill was never passed into law (HR. 6469, 1980).

The energy crises of the 1970's marked a number of 'firsts' for ridesharing. It was the first time that the federal government formally funded rideshare initiatives, it was the first time that ridesharing was prescribed as an air quality mitigation strategy and it was the beginning of formal academic research into rideshare motivations and the potential to reduce petroleum consumption. As with previous periods though, national rideshare statistics were just starting to be gathered, making it difficult to determine how influential the energy shortages and government-sponsored programs had been on participation. Much like ridesharing in the WWII-era, the federal government's involvement was largely a response to a resource shortage, in this case exclusively petroleum.

While many held strong hopes for ridesharing at the beginning of the 1980's, low oil prices and strong economic growth throughout the decade and into the 1990's dashed those hopes. The next rise in ridesharing would not occur until 2005.

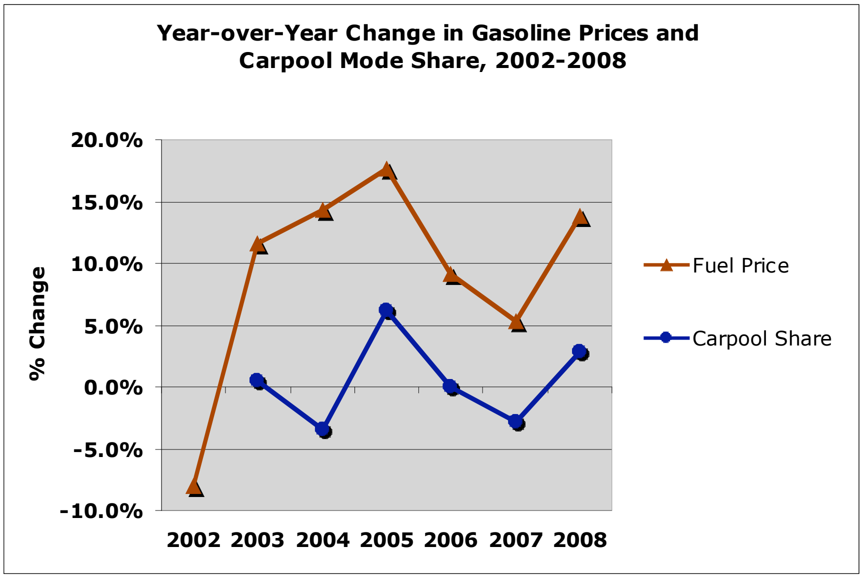
### 2.5.5 Period #4 – Late 2000's Energy Price Spike & Economic Recession

In the summer of 2004, the retail price of gasoline exceeded $2.00 a gallon for the first time in US history (in nominal terms) (EIA, 2009). Throughout the remainder of year and into 2005, the $2.00 mark was surpassed multiple times with prices eventually topping out above $4.00 a gallon for several months in the summer of 2008 (EIA, 2009). Within the context of higher than normal gasoline prices during the mid to late-2000's, it should not be surprising that ridesharing participation increased; as the previous periods of rideshare success have demonstrated, there has been a strong history of rideshare uptake during periods of high fuel prices, or fuel shortages.

A major difference during this period as compared to the previous ones was the availability of national rideshare statistics to measure changes in participation. In the 2005 American Community Survey, ridesharing as a method of commuting to work increased in percentage terms for the first time since 1970 when such data was first collected. Between 2004 and 2005, ridesharing saw a modest increase from 10.1% to 10.7% of trips to work and has held a more or less constant share through 2008 (US Census, 2005).

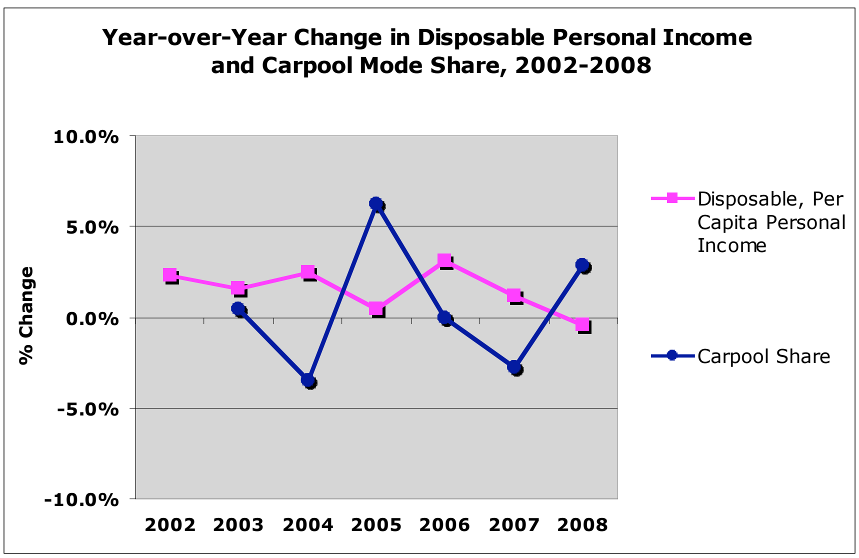
The influence of high gasoline prices on the changes in aggregate, nationwide rideshare participation from 2002 through 2008 is compelling. The first chart below shows the trend in year-over-year percent change in retail gasoline prices (in real terms) and in rideshare participation. As expected, the trends are similar; as gasoline prices rise, rideshare participation rises. The relationship between gasoline prices and rideshare participation has a Pearson's R (a measure or correlation between two variables) value of 0.65, suggesting a reasonably strong correlation, but highlighting that there are other factors influencing rideshare participation. In some respects, the price of gasoline may not really be the underlying cause for rideshare behavior changes; rather, it seems likely that tighter household budgets would be more indicative. If one compares the year-over-year change in rideshare participation and per capita disposable personal income (in real terms), one can see that the two move in opposite directions, as one would expect; as disposable income decreases, rideshare participation increases. The Pearson R value is -0.62 suggesting a similarly strong, inverse correlation as was observed between real gasoline prices and rideshare participation. This is an important observation as it may suggest that non-transportation related strains on household budgets (such as an economic downturn, or lower wage growth) are almost as likely to influence rideshare participation as gasoline prices are. If this hypothesis holds, one should expect to see continued high levels of ridesharing in 2009 due to continued economic weakness, even with the substantial decreases in retail gasoline prices.

**Figure 2.3: Relationship between Gasoline Prices and Carpool Mode Share**




Source: US Census, 2005 & US Department of Energy, 2009

**Figure 2.4: Relationship between Disposable Personal Income and Carpool Mode Share**




Source: US Census, 2005 & US Department of Commerce, 2009

Contrary to WWII and the 1970's energy crises, the federal government has been noticeably absent in encouraging ridesharing in this current period of growth. This period is more closely related to the jitney era whereby private entities stepped into the market where they perceived a gap in service. Entrepreneurs and private organizations are leading many of the current rideshare efforts, with some interest from local and state governments. While it is difficult to determine precisely why the federal government has not been involved, the lack of a large, national crisis such as those encountered during WWII and the 1970's oil embargoes probably explains it.

The 1970's were the first time that policy makers began to see ridesharing as a strategy to address problems other than petroleum shortages. As was discussed previously, it was believed at that time that ridesharing could be an effective mitigation strategy to improve air quality. By the mid-2000's, interest in ridesharing has expanded to include greenhouse gas (GHG) emissions reduction, the alleviation of congestion and the reduction of petroleum consumption. As with previous attempts to encourage ridesharing, the challenge that remains today is how best to link higher level societal goals such as the ones outlined above to the daily needs and travel behavior of drivers and potential passengers.

### 2.5.6 Major Trends from All Successful Rideshare Periods

The periods of successful rideshare participation have a number of similarities. First and most obvious is the link between ridesharing and high gasoline prices and/or gasoline scarcity. In all periods except the Jitney era, the availability and price of gasoline appears to have had an impact on rideshare participation.

Second, increased levels of rideshare participation have occurred during periods of geopolitical unrest (WWII & 1970 energy crises) or during economic downturns (Jitney era & Current). At a high level, this suggests that when participation has risen, it has been a function of extenuating circumstances. This is not to say that all ridesharing is influenced by economic and geopolitical factors; approximately 10% of Americans chose to share rides in the early-2000's prior to the increase in gasoline prices and the economic downturn, but it is indicative.

Third, due to the previous two trends, it is likely that household budgets were strained during all four successful rideshare initiatives. No conclusive evidence exists, but the situation during these periods suggests that it was likely. If this theory is indeed true, it poses a particular challenge for policy makers to think of creative ways to encourage ridesharing that do not rely on decreases in financial freedom. If one thinks of strained household budgets as a "stick" approach to behavior change, the challenge is to identify "carrots" that encourage desirable travel behavior.

Fourth, different stakeholder groups have encouraged ridesharing at different points in time. While the Jitney era and the late-2000's increase in rideshare participation have been driven by personal choices and some innovative entrepreneurs, the WWII era and 1970's energy crises were largely initiatives led by the federal government with the cooperation of the private sector (oil industry or large employers). Very little is known about the importance of metropolitan areas and state agencies in the history of ridesharing, beyond the fact that they operate many of the ridesharing services currently available. Future rideshare initiatives will need to encourage greater collaboration between all of these stakeholders.

This brief review of ridesharing's past has focused on the four periods of successful rideshare participation. The review has been largely qualitative and historical in nature. The next section will continue to look at ridesharing, but will focus more on current trends using quantitative statistics from various data sources and will begin to look at other factors important to ridesharing including socioeconomics, ethnicity and congestion.

## 2.6 Current Trends in Ridesharing

The trends and statistics described in this section should begin to paint a picture of the current state of ridesharing in the US. The majority of the data was gathered from the 2000 US Decennial Census (US Census, 2000), the 2001 National Household Travel Survey (NHTS) (US DOT, 2004), and the 2005-2007 American Community Survey (US Census, 2005), the most recent comprehensive national travel data sets that are available.

### 2.6.1 Historical Trend – Journey-to-Work

Ridesharing as a mode of travel to work was relatively popular in 1970 and 1980, accounting for approximately 20% of work trips. The 1980's were difficult for ridesharing; by 1990, the share of carpool trips had decreased to 13%, a loss of 3.6 Million commuters. Ridesharing reversed its fortunes somewhat in the 1990's and by 2000 had added back 250,000 participants. This increase was not sufficient to keep pace with the overall growth in commuters, resulting in a decrease in mode share to just over 12% of trips. The downward trend continued in the early 2000's but appears to have reversed course starting in 2005, likely due in large part to increasing gasoline prices.

**Figure 2.5: US Historical Carpool Mode Share, 1970-2008**

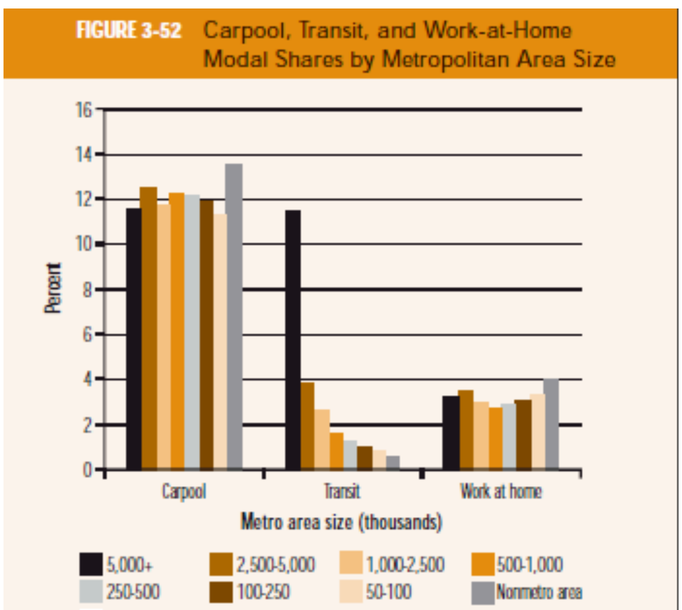
| US Historical Carpool Mode Share - Journey to Work - 1970-2008 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1970 | 1980 | 1990 | 2000 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| US Census, Commuting in America | 20.4% | 19.7% | 13.4% | 12.6% | | | | | | | |
| US Census, American Community Survey | | | | | 10.4% | 10.4% | 10.1% | 10.7% | 10.7% | 10.4% | 10.7% |

Source: US Census , 2005 & Pisarski, 2006

### 2.6.2 Carpool Mode Share by Metropolitan Size

In stark contrast to transit use, carpool mode share is very consistent across metropolitan areas of different population sizes. Not surprisingly, non-metropolitan region (rural) journey-to-work trips had a higher carpool share, as these commuters likely have longer commutes, fewer transport options and are more likely to achieve meaningful cost savings from carpooling. Overall, the finding that carpool mode shares are remarkably consistent across metro areas of different sizes is somewhat intuitive if one considers the effects of travel distance, transit availability and possible congestion effects. For the smallest metropolitan areas, commuting distances and congestion are likely to be minimal suggesting higher SOV shares, but and transit services are minimal or non-existent leading to some diversion to carpooling, particularly for those in lower socio-economic strata. As one progresses to larger city size categories, travel distance and congestion increase (suggesting higher carpool shares), but are partially mitigated by higher transit ridership (possibly replacing some carpool share). In the largest metro areas, the prevalence of extensive transit systems potentially has a stronger influence than travel distance or congestion effects explaining the drop in carpool share in the largest metros.

**Figure 2.6: Carpool, Transit & Work at Home Shares by Metropolitan Area Size**

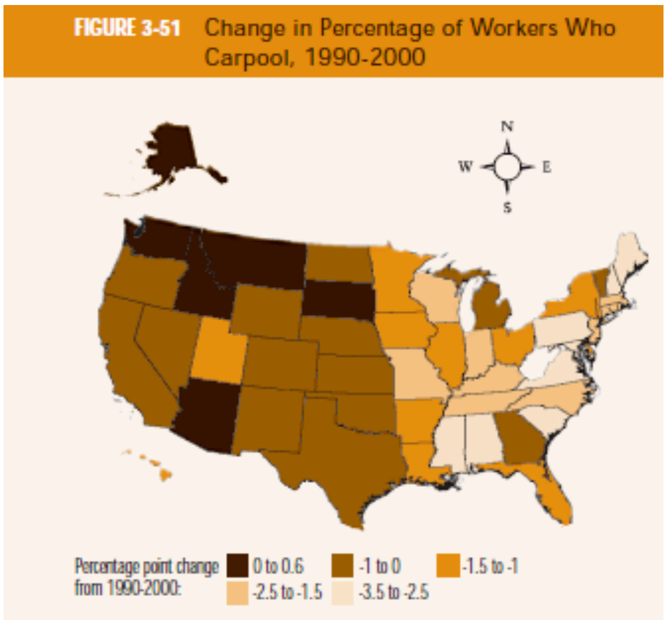



Source: Pisarski, 2006

### 2.6.3 Geographic Changes, 1990-2000

The geographic changes in ridesharing from 1990 to 2000 are quite pronounced. During the decade, only four metro regions of over 1 Million people had increases in carpool mode share and they were predominantly west of the Mississippi (Seattle, Phoenix & Dallas; Atlanta was the fourth). The map below paints an interesting story. While carpool mode share has been decreasing nationwide, the largest decreases have been in the eastern US and the largest increases have been in the western US. At the metropolitan level, the results are even more pronounced; of the top 10 metro regions with the highest carpool mode shares in 2000, eight are located in the US Southwest (CA, NV, AZ & TX).

**Figure 2.7: Change in Percentage of Workers who Carpool, 1990-2000**




Source: Pisarski, 2006

**Figure 2.8: Top 10 Metropolitan Regions by Carpool Share in 2000**

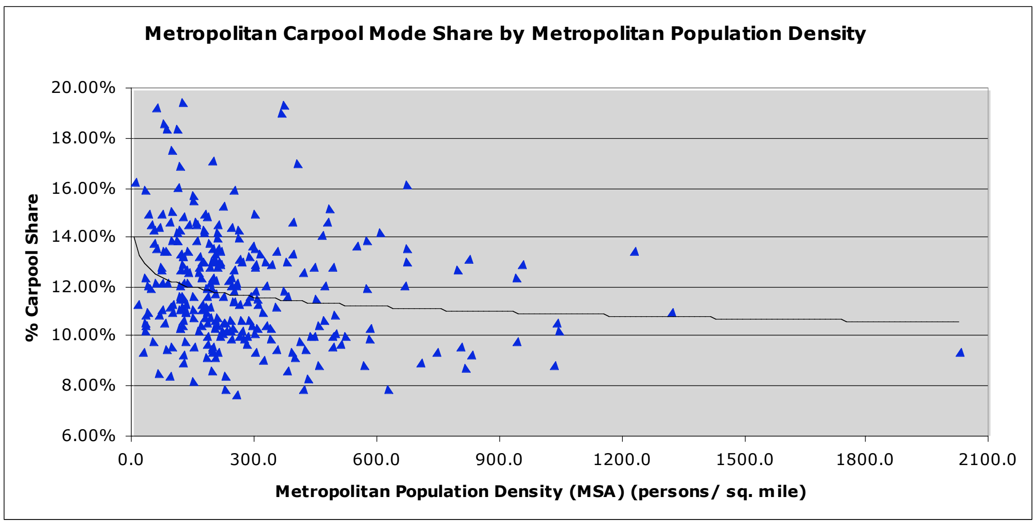
| Top 10 Carpool Metro Regions by Geographic Region (2000) | | | |
|---|---|---|---|
| Rank | Metropolitan Area | % Carpool | Geographic Region |
| 1 | Phoenix, AZ | 15.3% | Southwest |
| 2 | Los Angeles, CA | 15.2% | Southwest |
| 3 | Las Vegas, NV | 15.0% | Southwest |
| 4 | San Antonio, TX | 14.7% | Southwest |
| 5 | New Orleans, LA | 14.6% | South |
| 6 | Houston, TX | 14.2% | Southwest |
| 7 | Dallas-Fort Worth, TX | 14.0% | Southwest |
| 8 | Austin, TX | 13.7% | Southwest |
| 9 | Atlanta, GA | 13.6% | South |
| 10 | Sacramento, CA | 13.5% | Southwest |

Source: US Census, 2000

### 2.6.4 Metropolitan Density, Transit Share & Congestion

As was seen in the previous section, geographic differences within the US appear to have some effect on rideshare participation. One potential reason for this is differences in metropolitan population densities. Cities in the Northeast developed much sooner than cities in the South and West, and were not originally designed to accommodate private automobiles. The chart below suggests that density may have an influence on carpool mode choice; as population densities increase, carpool mode share falls. What this chart does not provide is any information on whether density itself leads to decreasing carpool mode share, or whether higher densities improve the viability of other modes of transportation (such as transit) leading to a mode shift away from carpool.

**Figure 2.9: Metropolitan Carpool Mode Share by Population Density in 2000**

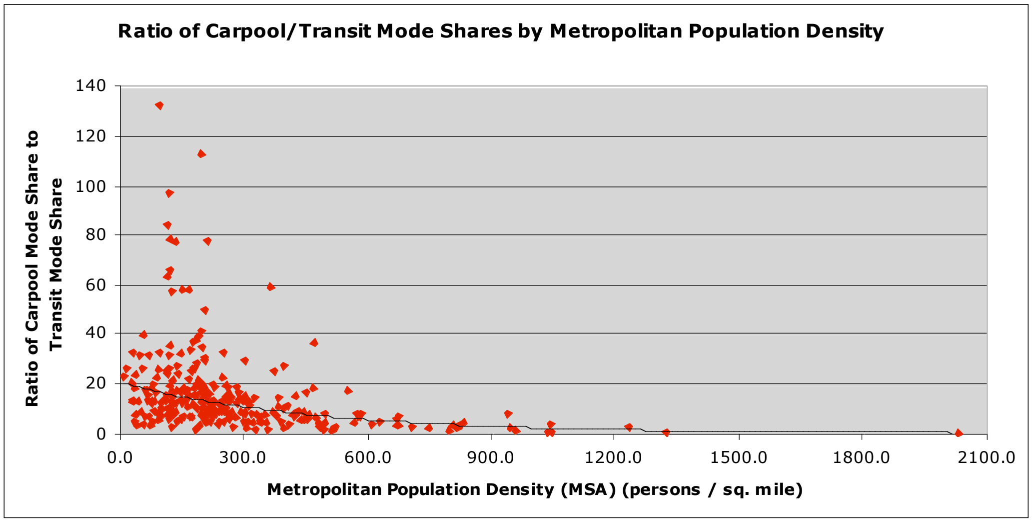



Source: US Census, 2000

Indeed, if one takes the ratio of carpool mode share to transit mode share, and compares it to metropolitan density, the picture becomes a bit clearer. At higher densities, transit is the dominant mode choice (low carpool / transit ratios) while at lower densities carpool is the dominant mode choice (high carpool / transit ratios). Intuitively this makes some sense if one believes that higher population densities are a prerequisite for viable transit service.

[Note: The density calculations in the two previous graphs were done at the MSA level. MSA's in the US are determined by county boundaries rather than any sort of density gradient. As such, MSA's that include large counties with a primarily rural population (many in the US Southwest, for example) will have lower densities than their smaller urbanized areas.]

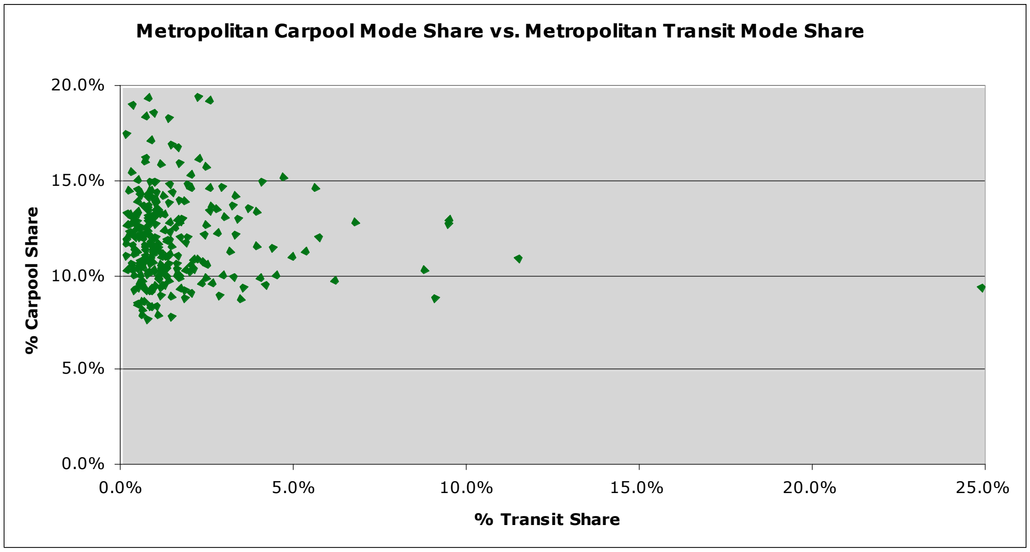
**Figure 2.10: Ratio of Metropolitan Carpool-to-Transit Mode Share by Population Density in 2000**




Source: US Census, 2000

One of the implications that may be drawn from the previous chart is that carpool and transit appear to compete for mode share. As will be demonstrated in the International section later in this chapter, this appears to be at least somewhat true at an aggregate level. However, at a disaggregate level (in this case, at the metropolitan level), this relationship is not certain. The chart below plots metro region carpool and transit shares against one and other. If the relationship between carpool and transit were strong, one would expect to see a relatively obvious top-left to bottom-right trend in the data points. In actuality, the data does not show any strong relationship between carpool and transit mode share at the metropolitan level.

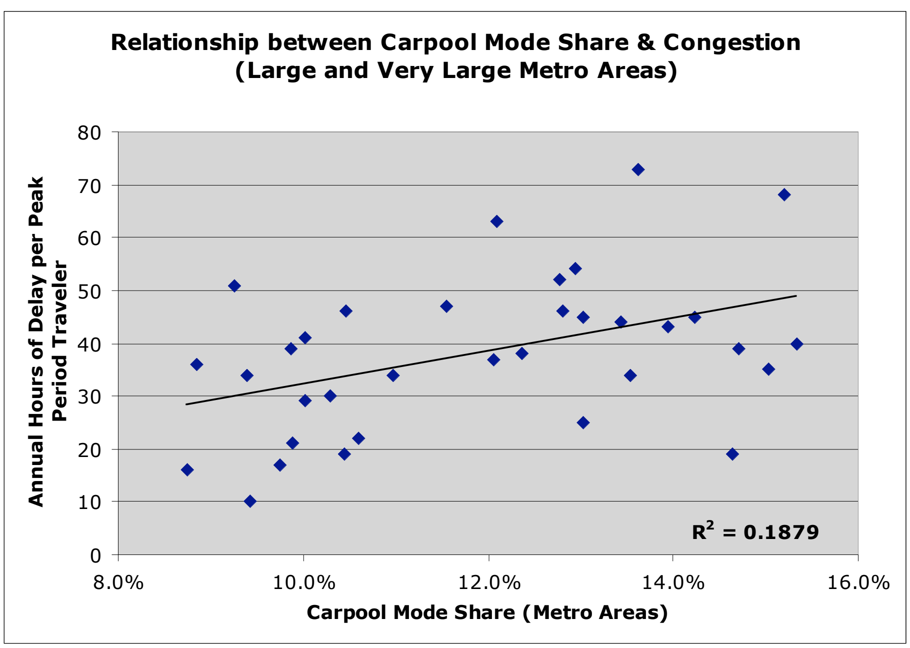
### Figure 2.11: Metropolitan Carpool Mode Share vs. Metropolitan Transit Mode Share in 2000




Source: US Census – 2000 Decennial Census

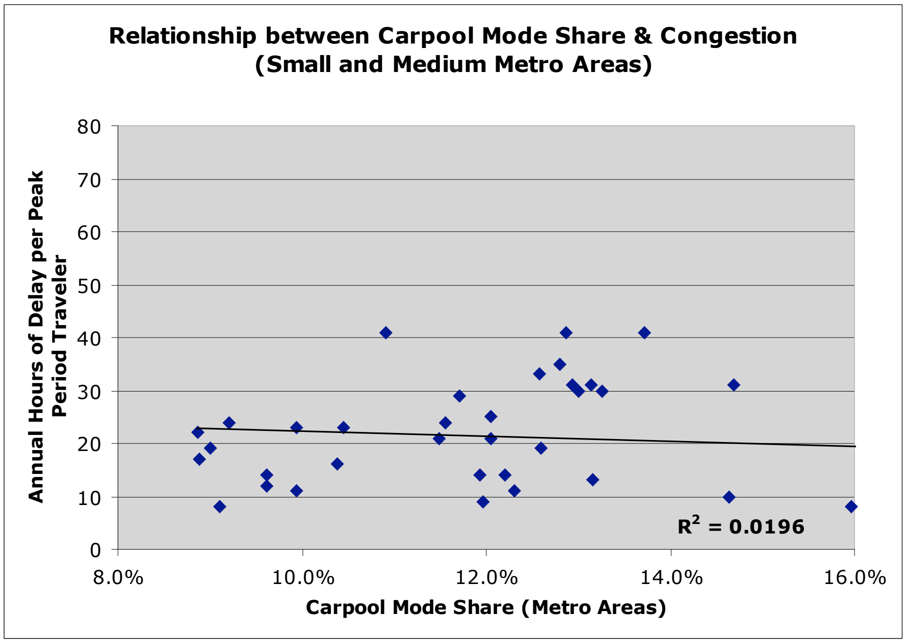
Shifting to an analysis of the relationship between congestion and ridesharing, one can observe from the charts below that at the metropolitan level there is a consistent, positive trend. This is expected; as congestion increases, commuters often seek alternative travel options. It is curious that the trend is much more pronounced for large metro areas than it is for smaller ones.

### Figure 2.12: Relationship between Carpool Mode Share & Congestion in Large and Very Large Metropolitan Areas in 2000




Source: US Census, 2000 & Schrank & Lomax, 2009

**Figure 2.13: Relationship between Carpool Mode Share & Congestion in Small and Medium Size Metropolitan Areas in 2000**



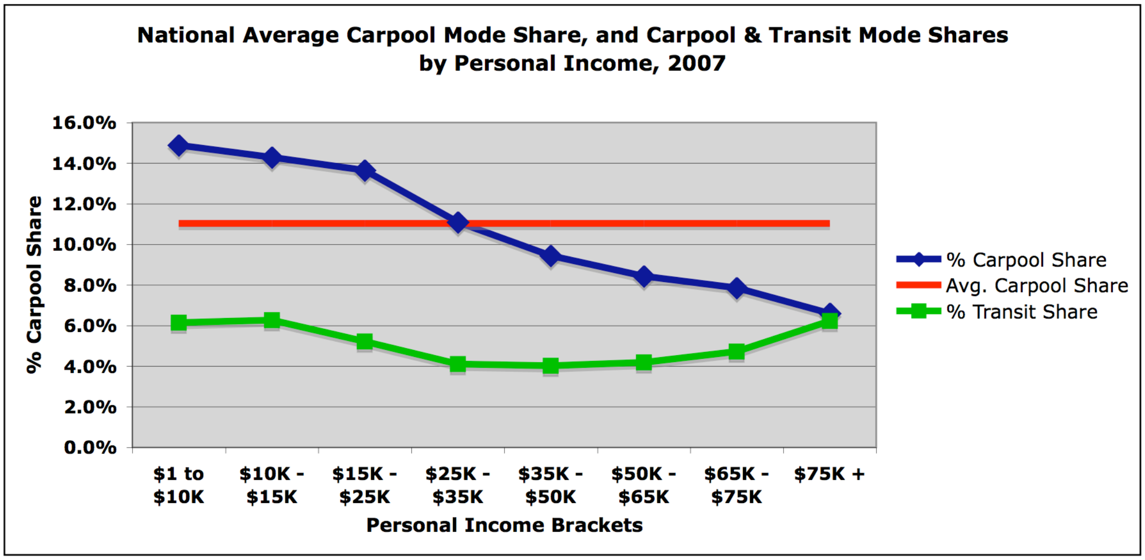

Source: US Census, 2000 & Schrank & Lomax, 2009

One unsubstantiated hypothesis regarding the lack of relationship between congestion and carpool share for smaller metro areas would be the lack of HOV facilities. Although no analysis was performed, it was assumed that the majority of freeway HOV facilities are found in the larger US metro areas. For metro areas with HOV facilities, the presumption is that as metro level congestion increases, commuters form carpools to take advantage of less congested HOV lanes. In these cases, there is an obvious travel-time savings benefit for the driver and likely for the passenger. From a financial standpoint, there is less of an impetus to carpool when HOV lanes are not present.

### 2.6.5 National Level Personal Income and Carpool Mode Share

Intuitively, many believe that carpooling has an inverse relationship with personal income; as income increases, families purchase additional vehicles, single occupant vehicle trips increase and carpool participation decreases. Indeed, national level journey to work data suggests this inverse relationship does exist between personal income and carpool share; carpool mode share decreases in every income bracket. This is in contrast to transit mode share, which first decreases with increasing income, but reverses the initial trend and increases in the higher personal income brackets.

**Figure 2.14: Carpool and Transit Mode Shares by Personal Income Bracket, 2007**

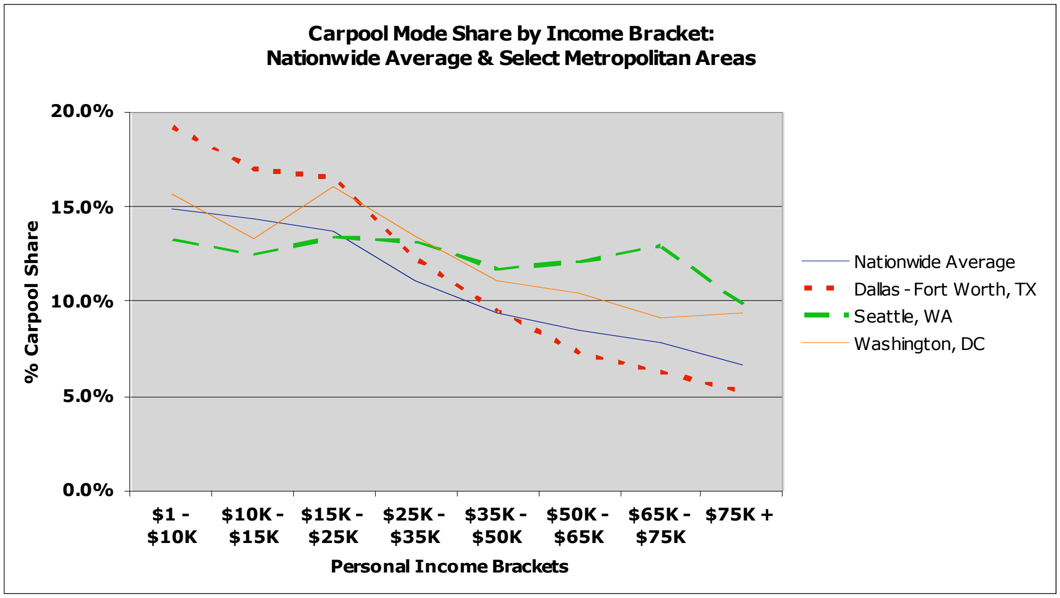



Source: US Census, 2005

### 2.6.6 Metropolitan Level Personal Income and Carpool Mode Share

The relationship between personal income and carpool share at the metropolitan level is basically the same as the national level trend. In almost all cases, metro region carpooling decreases steadily with increasing income. Dallas-Fort Worth, TX is a good example of this. Carpool mode share for those earning less than $25K is well above 15%, yet decreases to just over 5% for those earning more than $75K. Washington, DC is one of only two cities in which carpool mode share increases (albeit marginally) in the highest income bracket (Orlando, FL is the other metro area). Seattle, WA is perhaps the most interesting metro region. Carpool share remains remarkably consistent over all income groups (13.3% for those earning less than $10K, 13.0% for those earning $65-$75K), only showing a noticeable decrease for those in the highest income bracket. In fact, Seattle has the highest carpool mode share of any metro area with a population over 1M. for those earning between $50-$75K. It is likely that Washington State's Commute Trip Reduction legislation for large employers (the only statewide legislation of it's kind) explains some of Seattle's higher than average carpool mode share in the higher income brackets.

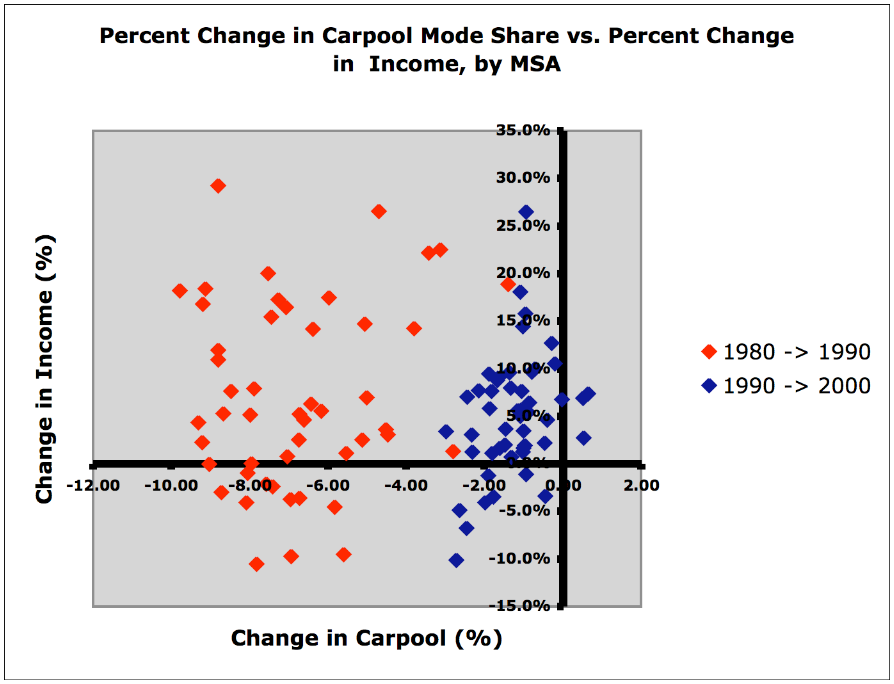
**Figure 2.15: Nationwide and Select Metro Area Carpool Mode Share by Personal Income Bracket**




Source: US Census, 2005

When the metropolitan level data is analyzed over time, the income trend is not significantly different; the *change* in inflation-adjusted household income at the metropolitan level has a discernible, but varied impact on carpool mode share. One can see that decreases in carpooling have commonly occurred when household incomes have risen (top-left quadrant); however, there are instances when decreases in carpooling have been associated with decreases in income (bottom-left), and more recently, increases in carpooling have been observed when income has increased (top-right). With the sharp decrease in gasoline prices and robust economic growth in the 1980's, it is not surprising that the carpool share showed a large decrease across many metropolitan areas. Overall, the data suggests that increasing levels of income are associated with a decrease in carpool mode share, both at the national and metropolitan levels.

**Figure 2.16: Percentage Change in Carpool Mode Share and Personal Income by Metropolitan Area, 1980 to 1990, and 1990 to 2000**




Source: US Census, 2000

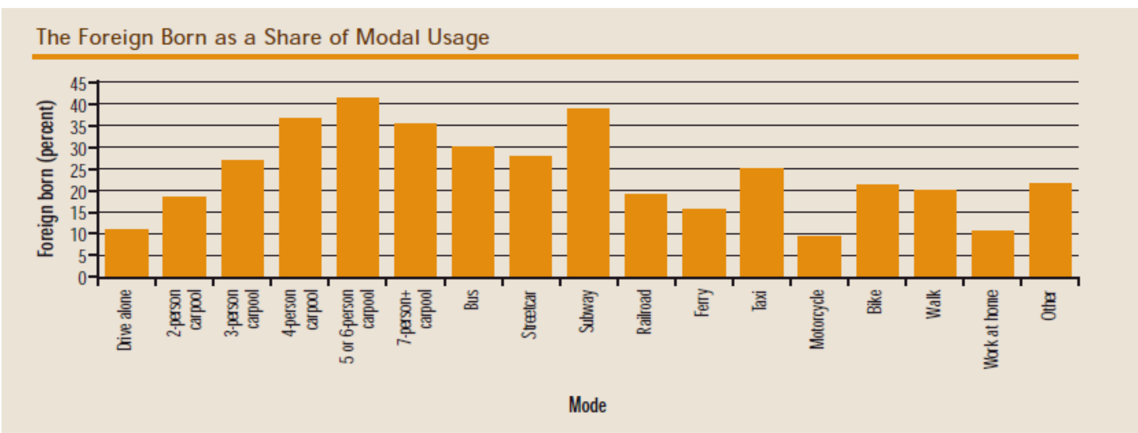
### 2.6.7 Carpooling Among Family Members, Relatives & Co-Workers

In 2000, 77% of nationwide carpools involved two individuals (the driver and one passenger). Of these two-person carpools, it is believed that 25-80% are "fampools", carpools comprised of family members, depending largely on trip type. Attanucci (1974), in a survey of commuter carpooling in Boston, places the percentage between 25-45%, with co-workers representing another 50-70%. Kendall (1975), in a survey of Boston commuters found that 35% of carpools were intra-household. However, recent sources place the percentage of commuting involving family members much higher. Pisarski (2006) suggests the percentage is closer to 80% but provides no supporting evidence. Li (2007) in a survey of Texas carpoolers found that approximately 65% were family members, with co-workers representing another 30%. Morency (2007) using survey data from Montreal, Canada found that 82% of carpoolers were family members with another 9% representing co-workers. Note that the Attanucci and Kendall surveys, while several decades earlier, were surveys of commuter carpoolers specifically, and found a much lower share of household members and a much higher share of co-workers. The Li and Morency surveys focused on all trip types and found much higher intra-household participation. Intuitively, it is expected that commuting trips would involve smaller percentages of family members than trips for other purposes. Carpool statistics from MIT tend to support this; approximately 59 of 234 employees (25%) with registered carpool parking permits are family members (L. Brutti, personal communication, May 6, 2009). Note that this percentage is an understatement of true "fampools" at MIT, because employees that are dropped off at campus by a family member cannot be identified through parking permit registration. However, the statistics certainly suggest that "fampooling" for commuting trips is much lower than the 65-80% quoted elsewhere. Beyond considerations of trip type, it is clear that the percentage of carpooling occurring between unknown participants is rare; Attanucci (1974) found 3%, Li (2007) found 3-5% and Morency (2007) found approximately 9%.

### 2.6.8 Immigration, Length of Stay in the US & Ethnicity

In 2000, immigrants to the US accounted for slightly less than 14% of the working population, yet they made up nearly 20% of the share of 2-person carpools and over 40% of the share of carpools with 5+ persons or more.

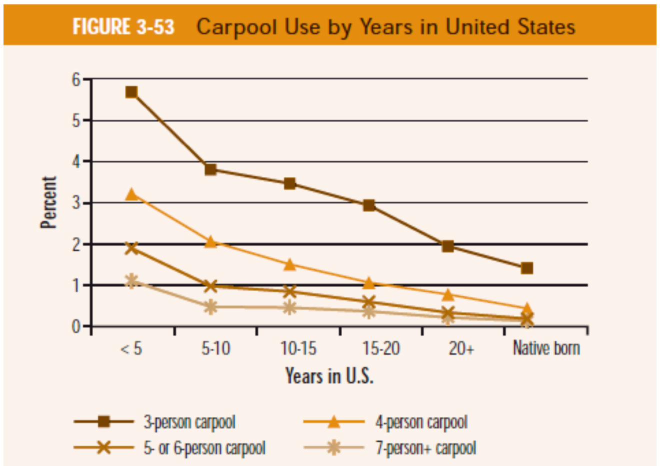
**Figure 2.17: Foreign Born Americans as a Percentage of Modal Usage**




Source: Pisarski, 2006

Additionally, there is evidence that recent immigrants are much more likely to carpool than those that have lived in the US for some time. The reasons for this are not entirely clear, however cultural norms and disposable income are believed to be important factors. When immigrants first arrive in the US, they may not have the disposable income to purchase a personal vehicle and may choose to carpool instead. Further, it is believed that many recent immigrants arrive from nations that have stronger preferences or cultural norms towards shared vehicle use.

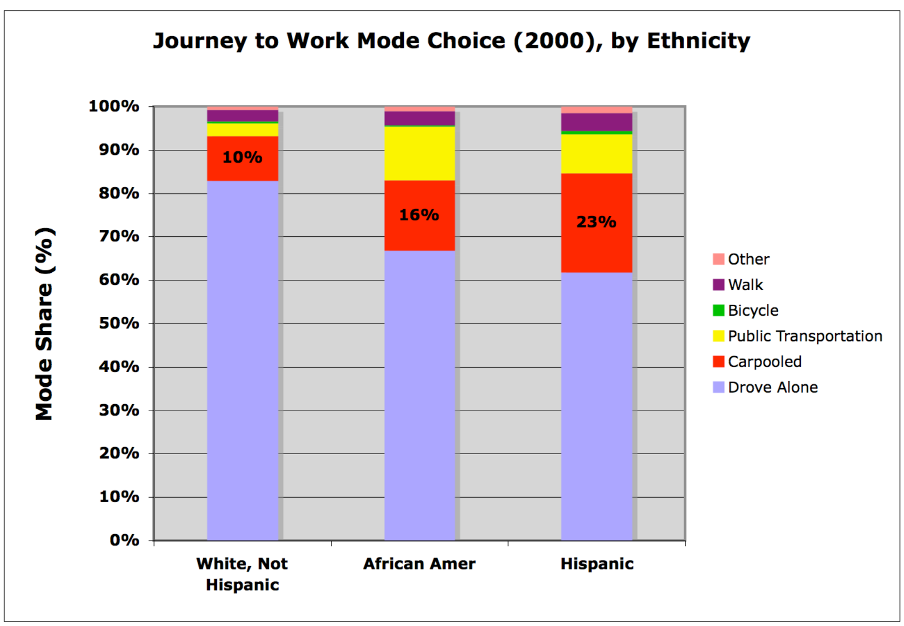
**Figure 2.18: Carpool Use as a Function of Years Living in the US**




Source: Pisarski, 2006

The 2000 Census data also shows that the incidence of carpooling is much higher among Hispanic Americans than it is for any other ethnic group. White, non-Hispanic Americans' carpool share is only 10% for commuting trips while the share for African Americans is 16% and the share for Hispanic Americans is 22%. This finding may begin to explain the high rideshare mode splits in the metro areas of the US Southwest, where Hispanic populations tend to be concentrated.

**Figure 2.19: Journey to Work Mode Choice by Ethnicity in 2000**

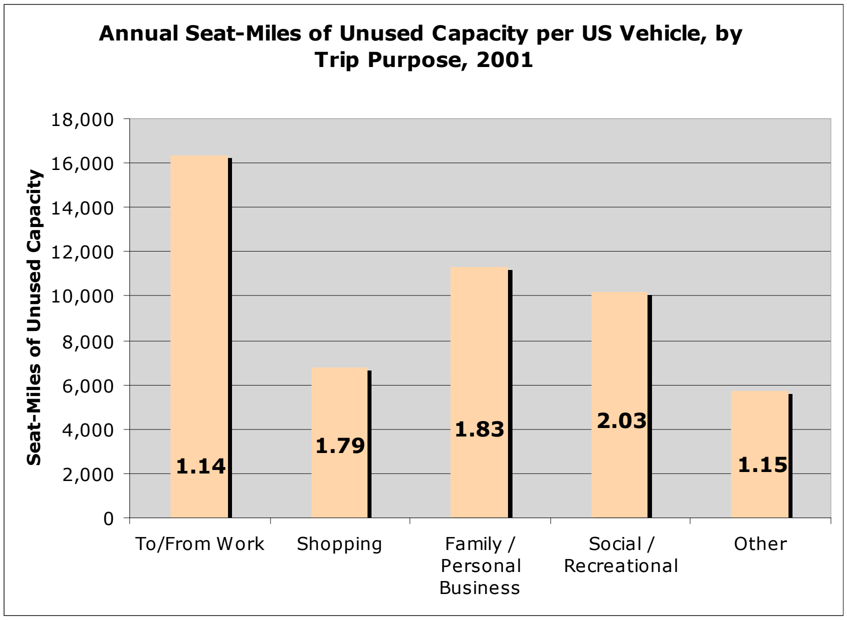



Source: US Census, 2000

### 2.6.9 Non-Commute Rideshare

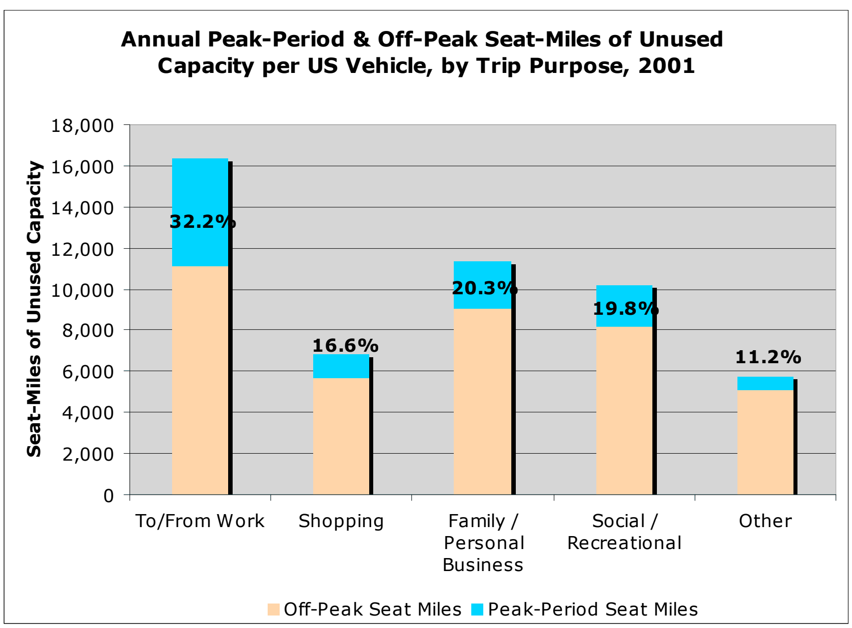
Most of the statistics quoted in this chapter have been based on commuter trips, or Home based Work (HBW) trips. Examining vehicle occupancy rates for all trips (including HBW) presents a different picture of shared vehicle use. According to the 2001 NHTS, multi-occupant vehicle trips (i.e. carpool trips) account for 48.9% of all trips as compared to 12.6% of commuting vehicle trips. This is an interesting fact to consider when developing a rideshare strategy. Given the much higher occupancies of non-commuting trips, it may be tempting to suggest that these types of trip are in some way more conducive to shared travel and as such, they should be the focus of rideshare efforts. Whether this is true or not, a question that must be posed is what the ultimate goal of shared vehicle use is? If the main goal is simply to maximize occupancy, than this may be a worthwhile effort. If the main goal is however to target trips that cause congestion and overload the network (leading to costly infrastructure expansion), than there is probably more value in focusing on increasing the occupancy of commuting trips. One potential method of thinking through the question of rideshare viability for different trip types would be to compare the number of empty seat-miles by trip type for the average US vehicle. Figure 3.19 shows that commuting trips constitute the largest source of free vehicle capacity. Taking this analysis one step further, it is possible to look at the percentage of those empty seats by trip type that occur during the congested AM & PM peak hours. Using research by Nair and Bhat (2003) on the distribution of trips by trip type and time of day for Dallas, TX, those empty seat-miles can be assigned to peak periods and off-peak periods (Figure 3.20). Nearly half of all peak-period free capacity is present in vehicles undertaking commuting trips. So while lower-occupancy, commuting trips only account for 16% of total person trips in the US, they represent 22% of vehicle trips, 27% of VMT, approximately 33% of empty seat-miles nationwide and 46% of peak-period empty seat-miles (if Dallas, TX is assumed to be typical in terms of the times of day that people commute). So while commuting represents only 1/6 of the trips on any given day, they represent nearly 1/2 of all free vehicle capacity during congested peak-periods. This suggests that shifts from SOV to HOV during weekday commuting will have a positive impact on congestion.

### Figure 2.20: Annual Seat-Miles of Unused Capacity per US Vehicle, by Trip Purpose in 2001




Source: National Household Travel Survey, 2001

### Figure 2.21: Annual Peak-Period & Off-Peak Seat-Miles of Unused Capacity per US Vehicle, by Trip Purpose in 2001




Source: National Household Travel Survey, 2001 & Nair & Bhat, 2003

### 2.6.10 International Trends in Mode Choice

Carpooling as a percentage of commuting mode share in the US is relatively high compared to other developed countries. The table below summarizes the mode split for commuting trips for the US, Canada, the UK and Australia. The US has a substantially higher level of ridesharing than any of the other three nations. It is interesting to note however, that all three other nations have substantially higher public transit mode shares than the US. If the two modes (carpool & public transit) are considered together, the combined share is quite similar across countries. At an aggregate level, this seems to suggest that the two modes may be competitors and that in the absence of adequate transit, commuters opt for ridesharing. To some degree, this assertion is supported by the fact that the strongest rideshare markets in the US have relatively low transit availability, and vice versa.

**Figure 2.22: International Comparison of Work Trip Mode Shares**

| International Comparison of Work Trip Mode Share | | | | | | | |
|---|---|---|---|---|---|---|---|
| Nation | Personal Vehicle, Driver | **Personal Vehicle, Passenger** | **Public Transit** | Walked | Cycled | Other | **Carpool & Public Transit** |
| United States | 78.2% | **12.6%** | **4.7%** | 3.0% | 0.4% | 1.0% | **17.3%** |
| Canada | 73.8% | **6.9%** | **10.5%** | 6.6% | 1.2% | 1.0% | **17.4%** |
| UK | 62.0% | **8.0%** | **14.0%** | 11.0% | 4.0% | 1.0% | **22.0%** |
| Australia* | 71.0% | **7.6%** | **8.5%** | 4.7% | 1.2% | 7.1% | **16.0%** |

*The Australian Bureau of Census considers multi-modal trips. These have been included in the 'Other' category.
Multimodal trips frequently involve at least one public transit leg. Multi-modal trips with a transit leg account for 3.4% of the 7.1% 'Other' category.

Source: US Census, 2000 / Statistics Canada, 2001 / UK Dept. for Transport, 2002 / Australian Bureau of Statistics, 2001

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# Chapter 3: Previous Rideshare Trials, Rideshare Motivations and the Importance of Incentives & Marketing

Having defined ridesharing, reviewed its history and identified some of the key characteristics of the population that shares rides in Chapter 2, this chapter will focus more heavily on the behavioral aspects of ridesharing. A review of previous technology-based rideshare trials is undertaken, in an effort to understand how travelers have responded to concerted initiatives to encourage a change in their behavior. Particular focus is given to understanding the setup of the trials, the outcomes observed and any recommendations for future trials. The findings from these previous trials will inform the design of a rideshare trial for the MIT community in Chapter 8. The responses from several rideshare surveys will also be reviewed to begin to understand what motivates travelers to share rides. Differences in motivations across geographic locations will be highlighted, as will the differing motivations of drivers and passengers in rideshare arrangements. The third section of this chapter will present some recent findings on the importance of incentives and marketing in encouraging travel behavior change and how a number of these innovations could be applied to rideshare initiatives. The review of the behavioral literature in this chapter should not be viewed as comprehensive, but rather a review of the most relevant literature for the design of a community-based rideshare trial at MIT.

## 3.1 Technology-based Rideshare Trials

Technology-based, shared transport trials have been undertaken in fits and starts. The first uses of advanced technology to encourage more efficient shared vehicle transport were in transit applications. Several demonstrations used communication technologies (and later automatic vehicle location [AVL] technologies) that allowed vehicles to deviate from their routes to pickup/drop off passengers at more convenient locations. While technically not trials of ridesharing per the definition used in this thesis, the following two transit trials are worth considering because of their flexible use of transit vehicles and application of advanced technologies. Given the number of shuttle buses on and around the MIT campus, it is conceivable that a rideshare trial could incorporate private vehicles as well as MIT-operated vehicles.

### 3.1.1 German Flexible Operations Command and Control System (FOCCS)

In 1981, the German town of Friedrichshafen implemented a dynamically-routed, shared transport service that combined aspects of fixed route transit, dial-a-ride services and taxi service. In the preceding years, the town had experimented with a fully flexible dial-a-ride, checkpoint-to-checkpoint bus system called "Ruf-bus" (Behnke, 1993). Rather than provide full door-to-door service, community checkpoints were established. In the four years after implementation, the Ruf-bus system had approximately 35% more ridership than the previous fixed-route system that it had originally replaced (~44,300 passengers a month), but was nearly 75% more expensive to operate, per passenger (Behnke, 1993). In an effort to control costs, the town altered the service to a dynamic, flex-route transit system called the Flexible Operations Command and Control System (FOCCS).

FOCCS established transit routes that had a series of fixed stops and a large number of optional stops that drivers could travel to if a service request was received. This allowed passengers to show up unannounced at a series of fixed stops and provided customers the opportunity to receive more customized services at an optional stop, if the passenger requested service ahead of time. To request service at optional stops, travelers could send in an information card (generally used for recurring trips), place a phone request, or use an automated kiosk at popular stops (Behnke, 1993). Travelers input their current stop number, their destination stop number and their desired travel time (for kiosk users, it was assumed that travel was as soon as possible). A central dispatch computer received the request and the assigned service vehicle would be sent what amounted to a fax outlining the drivers' updated itinerary. In the case of kiosk requests, the central computer would typically transmit a trip confirmation to the requestor within 20-30 seconds (Behnke, 1993). Depending on expected demand, vehicles with different capacities were used; transit buses and a small fleet of taxis were outfitted with fax-like capabilities. This allowed vehicle capacity to be better matched with expected demand. In the event that a large number of requests were received on short notice, several smaller vehicles could be dispatched to fulfill the demand without unduly impacting scheduled service at the fixed stops. After some initial experience, it was common for the system to operate as a fixed route bus during peak periods, a flex-route service during the midday and as a checkpoint-to-checkpoint service during the early morning and evening hours (Cervero, 1997).

By 1987, the FOCCS service, while providing a lower level of customization than the Ruf-bus system still managed to serve 15% more passengers than the fixed-route service (vs. 35% more for Ruf-bus), but only cost 20% more per passenger (vs. 75% more for Ruf-bus) (Behnke, 1993). Further technology enhancements were undertaken after 1987 including the addition of AVL capabilities; however cost control remained an issue throughout the post-1987 period.

The FOCCS trial was interesting in that it was an early example of how to combine automated trip scheduling software with communication technologies to provide nearly real-time, customized transit service. While technological innovation has progressed rapidly since the 1980's, the essential requirements of current dynamic rideshare services (wireless communication, scheduling software, location awareness) are largely unchanged. While the service experienced very few technological problems and demand was certainly sufficient, the consistently higher subsidy needed to provide service was FOCCS' major shortcoming.

### 3.1.2 Virginia Smart Flexroute Integrated Real-Time Enhancement System (SaFIRES)

In 1993, the Federal Transit Administration (FTA) funded an advanced public transportation trial proposed by the Potomac-Rappahanock Transportation Commission (PRTC) in Prince William County, Virginia. The trial was similar in many ways to the German FOCCS trial. It was one of the first US attempts to combine automated scheduling software, graphical user interface communication technologies, database management software and AVL capabilities in one package, similar to FOCCS. Second, it used a variety of vehicle types to match passenger demand to vehicle supply. Third, it allowed for different service offerings including fixed-route, flex-route and demand-response offerings depending on the level of demand (Cervero, 1997).

Starting in 1991, the PRTC offered a flex-route service called OmniLink. The service had a series of fixed stop locations that were covered by each transit vehicle. If those stops were not convenient for passengers, the OmniLink vehicle could deviate up to 1.5 miles from its route to pickup/drop-off passengers, but only if a formal request had been made (Casey, 2002). To place a request, passengers had to call an OmniLink phone number and provide the specifics of their desired trip to a customer service representative 48 hours before the journey. The representative would have to call the passenger back to confirm that the request could be accommodated. This was an incredibly time consuming and personnel intensive process for PRTC. By using the newly developed SaFIRES technology package, passengers would be able to call a representative as little as two hours before their journey and receive an immediate trip confirmation over the phone. The technology package provided further benefits including the real-time tracking of vehicles, improved passenger counting capabilities, and on-time performance tracking (Casey, 2002).

Between the initial launch in 1995 and the interim report in 1998, daily passenger trips on OmniLink services had increased from 2,000 to 22,000 (Casey, 2002). It seems likely that at least part of this substantial increase in passenger trips was due to a doubling in the number of OmniLink routes (from three to six) part way through the trial. Currently in 2010, OmniLink continues to operate six flex-route services in Prince William County.

The SaFIRES trial encountered a number of challenges. At the outset, no program manager was designated to take charge of the initiative (Casey, 2002). This lack of “ownership” within the agency created project implementation delays and exacerbated several technological problems. The second major problem encountered was a lack of technology integration. While the scheduling software and AVL systems were functional, they were installed independently of one another and were difficult to integrate (Casey, 2002). Further, the communication system that linked the main computer system to the vehicles and drivers was unreliable and worked only sporadically. Major findings from SaFIRES included ensuring that a project manager was selected prior to the start of the trial to oversee design and implementation, that compatible technologies be used, and that a technology integration plan be developed at the outset of the project (Casey, 2002).

Both of these early technology-based transit trials were relatively successful at increasing ridership in their respective jurisdictions. Although the SaFIRES trial demonstrated that technology integration could be difficult, both trials demonstrated that the bundle of AVL, automatic scheduling and communication technologies could be successfully used to provide dynamic, shared transport services. However, the ability to provide innovative services when the vehicles are within your control (as is the case in transit applications) is very different than when they are privately owned and operated. Around the same time as the SaFIRES trial, the FTA and FHWA funded a series of demonstrations on the US West coast to test the feasibility of dynamic rideshare matching between individuals. Four demonstrations were funded in Bellevue, WA, Los Angeles, CA, Sacramento, CA and Seattle, WA.

### 3.1.3 Bellevue 'Smart Traveler' Demonstration

The first of three 'Smart Traveler' demonstrations took place in Bellevue, WA between November 1993 and April 1994. The purpose of the demonstration was to test the functionality and use of an integrated travel information center; a single source of information including rideshare opportunities, real-time traffic information and transit schedules. The demonstration was funded by the FTA and WSDOT, and was operated by researchers from the University of Washington and the local TMA in Bellevue (Haselkorn et al., 1995).

At the outset, trial designers made a conscious effort to focus their recruitment efforts on businesses in downtown Bellevue. Businesses within a four-square block radius were targeted for participation, with additional blocks added part way through the trial (Haselkorn et al., 1995). Further, the designers limited registration to those individuals that had a common residential location, or traveled in a specific corridor. Three 'groups' were established, each roughly corresponding to a corridor used to access downtown Bellevue (Haselkorn et al., 1995). Rideshare matching would only be allowed within each group in an attempt to isolate only the most likely matches that would result in shared rides. Further, this corridor-based grouping established a type of "commuter social network" whereby each group was small enough that they could easily interact and get to know each other. For participants wishing to log their desire to share a ride, they would call a specified number and type in a user code. Since the origin and destination were already recorded in the system, participants only needed to specify their travel day and time. To identify possible matches, participants could listen to posted rides by calling the phone system, or could view rides using a wireless pager. If a participant found a potential match, it was up to them to contact their partner and organize the final details of the trip (Haselkorn et al., 1995). Marketing was directed at specific businesses in downtown Bellevue, but few incentives were offered to participants. A 'guaranteed ride home' feature did exist, but was not widely advertised.

Over the course of the five-month trial, 53 registered participants posted 657 shared rides (509 rides offered, 148 rides sought). The system recorded six shared rides occurring, but since the recording of completed trips was optional the actual number may have been higher. Since the matching up of drivers and passengers was left up to participants, there are no statistics on the number of matched trips (Haselkorn et al., 1995). This lack of information on match rates and rides undertaken highlights the problem of accurately measuring rideshare trips.

The post-demonstration evaluation found that participants viewed the design of the system and the technology positively; the use of the pagers was viewed as one of the strongest incentives to participate in the trial (Haselkorn et al., 1995). The severe mismatch between the number of rides offered vs. the number sought (4:1) was concerning. The researchers postulated that the lack of interest in being a rideshare passenger may stem from the small number of trial participants and the fear of being stuck at the office, a lack of incentives for passengers or the inconvenience of the service and its inability to automatically match drivers and passengers (Haselkorn et al., 1995).

### 3.1.4 Los Angeles 'Smart Traveler' Demonstration

The second 'Smart Traveler' demonstration was undertaken in the San Fernando Valley, just north of Los Angeles between July and September 1994. The demonstration was originally planned for a different part of the Los Angeles metropolitan area, but was moved at the last minute following the January 1994 Northridge earthquake and the significant loss of highway infrastructure in the San Fernando Valley (Giuliano et al., 1995). The goal of the Los Angeles 'Smart Traveler' demonstration was very similar to that of the Bellevue demonstration; designers hoped to create a single source of information including rideshare opportunities, real-time traffic information and transit schedules. Project partners included Caltrans, Los Angeles County Metropolitan Transit Agency and Commuter Transportation Services, the regional rideshare provider in Los Angeles (Giuliano et al., 1995).

In contrast to the Bellevue demonstration, Los Angeles designers did not choose to focus on a specific subset of commuters. Rather, all travelers were eligible to participate in the demonstration. The 'dynamic ride match' portion of the demonstration was combined with the Commuter Transportation Services' existing ride match software. Participants looking to post a shared ride were required to call a phone system and register their origin, destination and travel times. Participants looking for matches could use the same phone system or one of 77 kiosks installed at different locations around the Valley. If a posted ride was of interest, participants could opt to have the system send a recorded message to the potential partner, or they could call the person themselves (Giuliano et al., 1995). Virtually no marketing was undertaken, with the exception of some basic information about the program on the kiosks themselves. Based on the evaluation report, it does not appear that any major incentives were offered to encourage participation.

During the trial, the system was used by an average of 34 people per week. Since participants were left to establish rides on their own, no information on the number of matched rides was available, nor was there a requirement to record successful shared rides, so this information was also unavailable (Giuliano et al., 1995).

The post-demonstration evaluation determined that the major reasons for the lack of participation was the near absence of marketing and promotion, and the hesitancy of travelers to share rides with strangers. Recommended improvements included much greater planning upfront, particularly the design of the demonstration, and much clearer procedures for measuring participation and analyzing travel impacts (Giuliano et al., 1995).

### 3.1.5 Sacramento Real-Time Rideshare Test

The Sacramento test was led by Caltrans in partnership with the FTA, several Sacramento-area TMA's and the University of California at Davis. After conducting several focus group meetings to identify user needs and gathering nearly 1,000 surveys from rideshare users and non-users, the test was undertaken starting in late 1994 and finishing in early 1995. Participants seeking a rideshare opportunity would call the ride match number and provide their origin, destination and time of travel. An operator would manually search for matches based on origin and destination zip codes, and desired time of travel. A list of possible partners with relevant contact information would be provided while the participant was still on the phone. No automatic pairing took place; the participant had to call prospective partners (Kowshik et al., 1996). While this design was meant to provide information for one-time rideshare opportunities, it is clear that the use of technology was rather basic. Very little information was provided on the incentives offered, if any.

Over the trial period, 360 drivers agreed to register and offer rides for the real-time test. A total of ten requests were made leading to a single ride match, and it is unknown whether that match resulted in a shared ride (Kowshik et al., 1996).

The post-trial evaluation identified three major causes contributing to the poor results including a significant lack of promotion and marketing, a lack of incentives for sharing rides, and an inability to address the personal security concerns of riding with an unknown partner (Levofsky & Greenberg, 2001).

### 3.1.6 Seattle 'Smart Traveler' Demonstration

The third and final 'Smart Traveler' demonstration, and fourth technology-based rideshare trial in the 1990's was undertaken on the University of Washington campus in Seattle, WA between March and November 1996 (Dailey et al., 1997). This was certainly the most successful of the 'Smart Traveler' demonstrations, both in terms of its relatively high level of participation and its measurement and analysis of travel behavior. While the Seattle demonstration was focused exclusively on developing a ride matching system, it was part of a larger 'Seattle Wide-area Information for Travelers' trial that aimed to provide real-time traffic and transit information to travelers, much like the Bellevue and Los Angeles demonstrations. The demonstration team included FHWA, WSDOT, King County Metro and the University of Washington (Dailey et al., 1997).

The Seattle demonstration was only open to students, faculty and staff of the University of Washington. Of the trials reviewed, this was one of only two that focused exclusively on a single organization. The ride matching system was developed by researchers at the University of Washington and allowed participants to search for recurring, traditional rideshare arrangements or one-time rides (Dailey et al., 1997). The trial was also the first to rely exclusively on the Internet as its primary communication medium. Participants interested in sharing rides would submit their personal information and travel details online and would receive an e-mail with a list of potential matches. Final trip logistics were determined through e-mail or by telephone. A number of marketing approaches were undertaken. Flyers were distributed around campus advertising the launch of the new service, branded coffee mugs were given away, and every community member receiving a universal transit pass or parking permit was provided with a brochure on the new system (Dailey et al., 1997). Interestingly, no explicit incentives were provided to University of Washington community members for agreeing to participate.

Over the course of the seven-month trial, nearly 400 participants signed up for the service with a maximum of 200 participants 'active' at any point. Faculty and staff represented 68% of the registered participants and students made up the remaining 32%. Nearly 2,100 trips were logged over the course of the trial with approximately 700 ride requests logged. This yielded 150 matched rides of which at least 41 were undertaken. As with the Bellevue demonstration, there was no requirement to record successful shared rides so the actual number could be higher. A post-demonstration survey of a sample of the participants indicated that 38% typically rode the bus, 37% were existing carpool participants, 25% were SOV commuters and 5% were cyclists (Dailey et al., 1997).

The post-demonstration evaluation postulated that the relatively high level of participation was due in part to the fact that the system was only open to the University of Washington community, thereby allaying some concerns about traveling with a stranger. Further, the University's strict on-campus parking policy was seen as a strong disincentive to drive alone and a strong incentive to share rides (Dailey et al., 1997). Beyond strict parking controls however, there appeared to be no other incentives offered to encourage participation.

While the outcomes from the West Coast demonstrations varied in their levels of success, they had the benefit of being funded until results could be reviewed. Several demonstrations in the mid-1990's were cancelled before the implementation stage. Two such trials included ATHENA in Ontario, CA and MINERVA within multiple communities in the State of Oregon.

### 3.1.7 Failed to Launch: ATHENA (1994) and MINERVA (1996)

The ATHENA project in Ontario, CA was significantly more ambitious in its use of technology than the 'Smart Traveler' demonstrations had been. With funding from the City of Ontario and the FTA, ATHENA promised to provide users with custom PDA's that would connect to a central computer system with a ride matching package that would automatically pair up drivers and passengers. Once a match was established, the central computer would send the pickup location, pickup time and fare to the devices using cellular telephone messaging (Levofsky & Greenberg, 2001).

The system was one of the few demonstrations that would have begun integrating information on multiple modes of travel. Rides would be assigned to private vehicles or mini-buses based on whichever driver's route was nearest to the passenger, but if no ride could be established, a subsidized taxi would be dispatched. Multimedia kiosks were to be added to major event sites such as office building lobbies, shopping malls, schools, airports and train stations to allow access to the ATHENA system and to provide transit service information (Levofsky & Greenberg, 2001).

ATHENA also aimed to address some behavioral concerns with ridesharing. Descriptions of the driver and their vehicle would be sent the passenger's PDA prior to undertaking the trip. Upon meeting up, the driver and passenger would key in personal codes to confirm the trip was underway. This confirmation would also trigger the financial exchange between parties (Levofsky & Greenberg, 2001).

At the time, the technology to undertake this type of trial was not available, so the City of Ontario began the development of a prototype PDA. When the next City administration took power in 1996, the project was halted due to a lack of interest (Levofsky & Greenberg, 2001).

The MINERVA system was very similar in design to the ATHENA proposal in California. It aimed to use wireless communication devices to establish ride matches and it sought to link rideshare opportunities to existing transit, paratransit and taxi services. MINERVA was unique in that it also sought to limit the need for travel altogether. By integrating the system with e-mail, home shopping and telebanking options, it was believed that the need for certain trips could be eliminated altogether. The MINERVA project secured $5.5M in funding ($1.5M from the State, $3.0M in matching grants from local pilot sites and $1.0M from management consulting firms), but does not appear to have ever been implemented (Levofsky & Greenberg, 2001).

The past decade has seen renewed interest in technology-enabled, shared transport demonstrations. While only three of the most interesting trials making it to the implementation phase will be discussed, there is no shortage of innovative proposals that have been put forth (see Adams, 2007 / Community Solutions, 2007 / Gorton, 2008 / Hartwig & Buchmann, 2007).

### 3.1.8 Germany "M21" Mobility Services Trial

Much like the Seattle Smart Traveler demonstration, "M21" began with a large institution because of the obvious critical mass of potential participants. The trial aimed into integrate various types of information including roadway congestion, transit service schedules, commuter bus availability, and the ability to reserve a vehicle through an institution-specific carsharing service (Holzwarth et al., 2001).

The "M21" mobility trial was originally designed as a package of six interconnected services; a pre-planned carpool service, a real-time carpool service (referred to as a 'tele-shuttle), an employer-specific carshare system (referred to as a 'mobility pool'), an evaluation of providing commuter bus services, the provision of real-time traffic information and a tele-shopping service that delivered small grocery orders to the employer's office. The trial was a true public-private partnership, with Daimler-Chrysler, the State of Baden-Wurttenberg and the private-sector service provider each contributing 1/3 of the €10M. budget (Holzwarth et al., 2001). The focus of the description below will be on the pre-planned and real-time carpool services, and the carshare service, as they proved to be the most innovative in their design.

The pre-planned carpool service was designed to operate within a single-employer environment. Employees were reminded daily of carpool opportunities and were encouraged to log their availability to share a ride, or their need for a ride later that evening and for the following morning. Employees could log their offers/requests via the firms internal computer system or by calling a telephone number. At 2pm every day, the central computer system would match those that had expressed interest in sharing a ride for the afternoon commute and the following morning's commute and would notify all participants shortly thereafter via e-mail or text message. Information sent included the names and contact information of the participants, the departure time and a recommended fare. The central computer would assume that no driver was willing to incur more than a 10% travel time deviation, or 5 minutes, whichever was less. Employees that preferred traditional, longer-term carpool arrangement could still log their desire to share a ride if their traditional partners were unable to share a ride on that particular day, or if they were willing to share the ride with an additional individual. For registered participants that lived in sparsely populated areas where few shared ride opportunities were available, the system would ask whether they would be willing to meet at more heavily trafficked locations such as "Park-and-Ride" parking lots along major highways. A 'Mobility Guarantee' was provided to all participants and proved to be a major factor in the acceptance of the trial. If a passenger could not be matched on a given day and lived in an area that was deemed transit accessible, transit information would be provided along with a voucher redeemable for free travel on that day. For those passengers that did not live in a transit accessible area, access to a vehicle from the employer-specific carshare pool was provided free of charge (Holzwarth et al., 2001).

The design of the pre-planned carpool portion of this trial was innovative from a number of perspectives and addresses a number of traditional concerns associated with ridesharing. First, by sending daily reminders to all potential participants, rideshare options remained salient in the mind of employees. Second, the fixed 2pm matching time balanced the flexibility of occasional carpool opportunities sought by employees with the reliability of knowing ahead of time whether or not a ride home was going to be available. If no ride was available, a reasonable amount of forewarning allowed the participant to make alternate arrangements. Third, the system assumed that traditional, long-term rideshare participants were not likely to use this type of service, but allowed them to log shared ride opportunities nonetheless, thereby linking two types of ridesharing that are often viewed as separate. Fourth, the attempt to suggest higher trafficked common meeting locations likely increased match rates. Finally, the 'Mobility Guarantee' with its multiple travel options likely reduced some of the fear of being stuck at the office.

The "M21" trial provided a small vehicle fleet for carsharing. Interestingly, the fleet was largely established to support the 'Mobility Guarantee' service provided as part of the carpooling initiative. The fleet of vehicles would be provided to employees when a carpool match could not be established. The employee in question would be able to use the vehicle for the evening and for the return trip the next morning. If the vehicles were provided to employees for the evening, they became "tele-shuttles" (described further in the next paragraph) meaning that employees were required to transport other employees if last minute rideshare requests were received (Holzwarth et al., 2001). It is not clear whether employees were responsible for fuel expenses. While the trial planned to offer the vehicles for short-term rental during the daytime hours to improve utilization, this idea was not tested during the trial (Holzwarth et al., 2001).

The real-time, "tele-shuttle" portion of the "M21" trial was essentially a combination of the carpool and carshare services. The carshare vehicles were outfitted with a wireless telephone and navigation system. If an employee requested a ride on short notice (within an hour of travel), the central computer system would attempt to locate a "tele-shuttle" whose route passed by the employee's location. If a shuttle was identified, the requestor would be notified and the driver of the "tele-shuttle" would receive a phone call notifying them of the intermediate stop. The navigation system was used to determine an optimal route to the intermediate point (Holzwarth et al., 2001). The driver of the "tele-shuttle" was either an employee that could not be matched in the pre-planned carpool service, or was a volunteer that chose to drive the "tele-shuttle" on a daily basis in exchange for use of the vehicle during non-work periods. "Tele shuttle" drivers were expected to honor all passenger requests assigned to them in exchange for the rather substantial benefit of being provided with a private vehicle free of charge (Holzwarth et al., 2001). While sources did not describe how volunteer drivers were selected, one would hope that preference would be given to those whose travel route passed by a large number of employee home locations, in order to improve match rates.

The trial was initiated in 1999 at the 6,000-employee Daimler-Chrysler research facility. Within 9 months, 320 employees (~5%) had registered for the "M21" pre-planned carpool service. Registration would grow to approximately 500 employees (~8%) by the end of the second year. No information was provided on the number of matches or successful number of shared rides.

The findings from the trial were revealing. Marketing and advertising were seen as particularly important (Holzwarth et al., 2001). The personalized service provided by telephone customer service representatives was particularly important during the initial weeks of the trial, as participants were growing accustomed to the service. Not surprisingly, the service was most popular among suburban commuters with few alternative transport options. In many cases, participants were unwilling to accept even a 5% travel time deviation, particularly those commuters that were traveling on limited-access freeway systems. Passengers stated that they preferred being picked up at their home location because it allowed other family members to use their vehicle during the day. A survey of 132 employees after the first year of the trial found that the major motivations for registering included the added flexibility of occasional arrangements and the cost savings of leaving a vehicle at home. Features of the service that were viewed positively included convenient bookings, fair cost sharing and the 'Mobility Guarantee' feature (Holzwarth et al., 2001).

### 3.1.9 San Francisco Bay-area "Ride Now" Trials

The "Ride Now" trial is more accurately described as a series of three trials conducted in the San Francisco Bay-area between 2004 and 2006 (RideNow.org, 2008). All three trials aimed to improve upon existing casual carpool opportunities in the Bay-area by formalizing the arrangement ahead of time, thereby reducing the wait times experienced by passengers and drivers. While the relevance of the "Ride Now" trial design may be minimal as it relates to a trial for the MIT community, a number of the behavioral findings were interesting.

The three trials all relied on the "Ride Now" software program, a proprietary ride matching package that automatically paired up drivers and passengers when requests were received. Participants could log into the "Ride Now" website or call in a request. They were required to state their desired pickup/drop-off time and their desired location. Passengers were required to choose a 5-minute pickup window (eg: 7:15-7:20am), meaning they had to be near their desired start point prior to logging their request, or needed to be very certain of their travel plans. At least fifteen minutes prior to departure, the system would send a text message to participants confirming a match or notifying them that other travel options should be sought. If a match was made, participants were provided with the name and contact information of their designated partner. It was up to participants to arrange the final details of their trip over the phone (RideNow.org, 2008).

Two of the three trials were rather informal, organized by the "Ride Now" system developer. The trials focused on reducing wait times for casual carpool participants along the I-80 corridor by establishing matches before they arrived at their desired pickup points. The first trial was conducted all along the I-80 corridor, the second trial focused exclusively on the West Oakland BART station. In both trials, marketing was undertaken several weeks before the launch to encourage potential participants to join. Incentives were offered in both cases. In the I-80 trial, it was generally believed that AM casual carpool participation was sufficiently high, so incentives were only provided for the return trip. Drivers that offered a ride in the afternoon received $5 (the cost of parking at many BART stations) while passengers that sought a ride but could not be matched would also receive $5. In the West Oakland trial, the incentive package was much more complex, but essentially $5 was provided to drivers for offering rides ($2.50 in the morning, $2.50 in the afternoon). Passengers received no incentive. Both trials were halted within several weeks. The I-80 trial managed to attract 45 registered users, but on the first day only 19 posted rides and only five carpools could be established. By the third day, only six rides were posted and one carpool was made. The trial was halted at the end of the third day. The West Oakland trial could only register 12 users in the weeks leading up to the trial, leading to its cancellation before it formally began (RideNow.org, 2008).

Two reasons were cited for the lack of success in these first two trials. First, participants were hesitant to trust an unknown organization offering essentially an identical service to that already being offered. Second, this service does not allow for the gradual build up of participants to a critical mass; a substantial initial group of participants is needed when the service is launched (RideNow.org, 2008). Participants were only willing to endure a few unsuccessful attempts before they lost interest in the service. In essence, the number of new registrants willing to try the service did not match the number of participants that were losing interest in the service and dropping out.

The third trial was a more formal affair and involved a variety of stakeholders including FHWA, BART, and a variety of consultants. The trial was to take place at the Dublin-Pleasanton BART station and would test dynamic ridesharing's ability to address "the last mile" problem; getting passengers to and from the station to their home. The trial experienced a series of delays due to institutional issues between the stakeholders (ACCMA, 2006). Further, the setup was rather complex, and many participants stated that they had difficulty understanding it. Interested participants were required to attend an initial orientation session. BART credits of up to $32 were offered to those that attended the orientation. Initial incentives were offered but proved to be inadequate. Those registering either a ride request or offer were given a $5 BART credit, but only for the first five times they posted rides, effectively capping benefits at $25 in BART credits (ACCMA, 2006). Given that the trial was six months in length, the lack of longevity in the provision of incentives meant that participants lost interest in a short amount of time.

Over the six-month trial period in 2005/2006, 121 participants registered for the service, 1,170 ride requests were made (9.7 requests per participant) leading to 141 ride matches (12% match rate)(ACCMA, 2006). In general, participants preferred to be the driver in the arrangement rather than the passenger, much like the Bellevue Smart Traveler demonstration. Pre- and post-trial surveys indicated that the preferential parking incentive was the largest perceived benefit of users; BART provided 10 preferred parking spots for trial participants. The post-trial survey also indicated that most users felt reasonably comfortable with the "Ride Now" software, but disliked the small 15-minute notification window (ACCMA, 2006). Many would have preferred being informed of their match the evening before the morning commute. Recommendations from the trial evaluation suggested that future trials should seek a simpler design, should outline institutional roles clearly at the outset and provide much more personalized marketing, including participant-specific information on alternate modes of travel such as connector bus services (ACCMA, 2006).

### 3.1.10 European Commission OPTI-TRANS Trial

The most recent technology-enabled rideshare trial is still in the design stage, but is fully funded and is expected to proceed in mid-2010. The European Commission OPTI-TRANS trial aims to create a multi-modal personal traveler navigation system that is accessible from a mobile device. The system will utilize the Global Navigation Satellite System to locate travelers and provide travel information based on their current location. The project team is made up of five partners from four EU countries (Opti-Trans Consortium, 2009).

The system will link multiple sources of public and private transportation data into one application, and will provide travelers with a recommendation as to which mode of travel is most suitable for their needs. Information from local transit services (bus, metro, tram & rail) in Madrid, Spain will be integrated with rideshare opportunities, taxi availability, cycling opportunities and walking. The trial design includes important features including a differentiation of services for different types of traveler (commuter, occasional traveler, tourist), the specification of different user needs (fastest possible trip, cheapest possible trip, most environmentally friendly trip, trip with the fewest transfers, etc.), and the ability of users to choose their desired mode of contact (e-mail, text message, telephone call) (Opti-Trans Consortium, 2009).

While the trial has a large number of objectives, several of particular importance include the standardization of travel information across different transport service provider databases, and an extensive user trial with focus groups, surveys and orientation sessions to solicit as much user feedback as possible.

### 3.1.11 Lessons Learned from Technology-based Rideshare Trials

The technology-based rideshare trials reviewed were diverse in their design, their target audience, their use of technology and their timing. Yet, even with substantial differences there are a number of commonalities between the trials, generally relating to the design and management of rideshare initiatives, and behavioral lessons learned.

**Design and Management Lessons Learned:**

1. Targeting Large Employers appears to Increase Rideshare Viability

As the Seattle and M21 (and to a lesser degree, Bellevue) trials demonstrated, rideshare initiatives focused on a single large employer or several large employers in close proximity tends to lead to increased interest and participation. Working for the same organization is believed to reduce fears of shared rides between strangers, presumably because there is at least some common attribute between the participants. There is likely to be some mutual belief that the other participant will act more appropriately than a complete stranger would, under the assumption that both individuals may have to interact in a work setting at some future point in time. Even in cases where future work-related interaction is unlikely, there is the potential for the organization to discipline poor behavior, if a complaint were to be filed. In this sense, participants have some tangible form of recourse in the event of bad behavior, and the costs of bad behavior could be substantial (including employee dismissal). From a pure matching perspective, choosing a single, large employer establishes a fixed destination and changes the traditional "many-to-many" rideshare matching challenge to a "many-to-one" challenge. If participants can be encouraged to pair up at common meeting points, or specific corridors are targeted, the matching challenge can be further improved to a "few-to-one" relationship.

2. Technology Enabled the Innovative Trials, but was Rarely Cited as the Impetus for Behavior Change

All of trials reviewed utilized some form of innovative technology or software, but in very few cases was the technology cited as one of the main reasons for participating in the trial. The Bellevue demonstration was a notable exception, where participants cited the use of the pager as their strongest incentive to participate. This highlights the fact that technology enables the provision of more innovative rideshare services, but is rarely sufficient on its own to change travel behavior.

3. Institutional Issues, particularly a Lack of Management, was Problematic in some Trials

Institutional issues were problematic for a number of the trials. The Los Angeles and SaFIRES trials both lacked initial planning in the design phase, and the SaFIRES trial had no designated individual overseeing trial implementation. In the Ride Now trial, institutional disagreements significantly delayed implementation. These trials highlight the need to have a strong institutional sponsor for a rideshare initiative, particularly someone that understands the competing interests of different stakeholders. There is also a need to devote substantial effort to designing a trial that effectively measures rideshare outcomes, so that the results inform future initiatives.

4. Lack of Measurement of Successful Shared Rides was a Widespread Problem

The lack of measurement of successful shared rides afflicted nearly every technology-based trial that was reviewed. In some cases (Los Angeles & M21) successful rideshare measurement appeared to be overlooked entirely, leading to questions about how well the performance measurement portion of the trial was thought through. In other cases (Bellevue, Sacramento & Seattle) successful shared ride recording was voluntary. The Ride Now trial was the only one in which the number of shared rides was measured, and this was largely due to the configuration of the software. Advanced rideshare technologies could be used in future rideshare initiatives to improve performance measurement, particularly the number of successful shared rides undertaken.

**Behavioral Lessons Learned:**

1. Incentives, Disincentives & Marketing Affect Rideshare Behavior

Those trials that offered incentives to encourage participation (Bellevue, Ride Now & M21), disincentives to discourage SOV commuting (Seattle), or undertook substantial marketing and promotional efforts (Seattle, Ride Now & M21) tended to have higher participation than those that offered few if any incentives and undertook little marketing (Los Angeles & Sacramento). The challenge remains gaining institutional support for such endeavors. Incentives and marketing can be a substantial portion of a rideshare initiative budget and may be one of the first line items targeted during project development reviews. Demonstrating that the provision of incentives and marketing is a relatively modest investment as compared to other transportation investments will be important.

2. Fear of Strangers Often Cited as a Reason for not Sharing Rides

Concerns about sharing rides with a stranger were cited as the major reason for a lack of participation in the Sacramento and Los Angeles trials. While this is a long standing challenge in rideshare initiatives, the existence of casual carpool systems that operate daily show that this challenge can be overcome when the system is convenient and reliable for users. This finding highlights the need to target travelers that are part of a social network (large employers, for example) where the fear of strangers is reduced, and improve the convenience and reliability of rideshare systems so that “stranger danger” fears are perceived as less problematic.

3. Trial Participants much More Willing to be Drivers than Passengers

In those trials that measured the number of driver and passenger requests separately, drivers appeared to feel more comfortable offering rides than passengers felt requesting rides. In the Bellevue trial, passengers sought 23% of rides while the remaining 77% were rides offered by drivers. In the Ride Now trial, as seen in Figure 3.1, the breakdown of morning ride requests for a six week period was 56% driver offers, 15% passenger requests and 29% willing to act as either the driver or passenger. The Ride Now statistics are of particular interest given that participants were required to state their rideshare role preference when they first registered. During registration, 22% stated they would only want to be a passenger, 20% stated they would only want to be a driver and 58% stated they would be willing to act as either a driver or passenger. As the Bellevue post-evaluation noted, the small number of participants and perceived lack of reliability in finding a return ride in the afternoon may partially explain the “ride offer-ride request” disparity.

**Figure 3.1: Ride Now! Trial Disparity in Stated vs. Observed Rideshare Role Preferences**

| Ride Now! Trial - Disparity in Stated vs. Observed Rideshare Role Preferences | | | |
|---|---|---|---|
| | Role in Rideshare Arrangement | | |
| | Driver | Passenger | Either Driv. or Pass. |
| Stated Preference (during registration) | **20%** | **22%** | **58%** |
| Observed Preference (ride requests posted) | **56%** | **15%** | **29%** |

Sources: RideNow.org, 2008 / ACCMA, 2006

4. Personal Travel Planning may Increase Interest in Future Rideshare Initiatives

The evaluations for the Ride Now and M21 trials both highlighted the importance of personalized marketing and travel planning in increasing interest in rideshare initiatives. While the evaluation for the Ride Now project simply recommended personal travel planning as a strategy in future trials, the M21 evaluation found that personal support in the initial stages of implementation was highly valued and one of the main reasons for choosing to participate. The use of detailed surveys prior to trial implementation may not only identify which subset of the traveling population should be the target of rideshare initiatives, but may also provide individual motivations and potential concerns with ridesharing. If these are known in advance, marketing materials and incentive packages can be customized for individuals or groups of potential users.

## 3.2 Rideshare Traveler Motivations

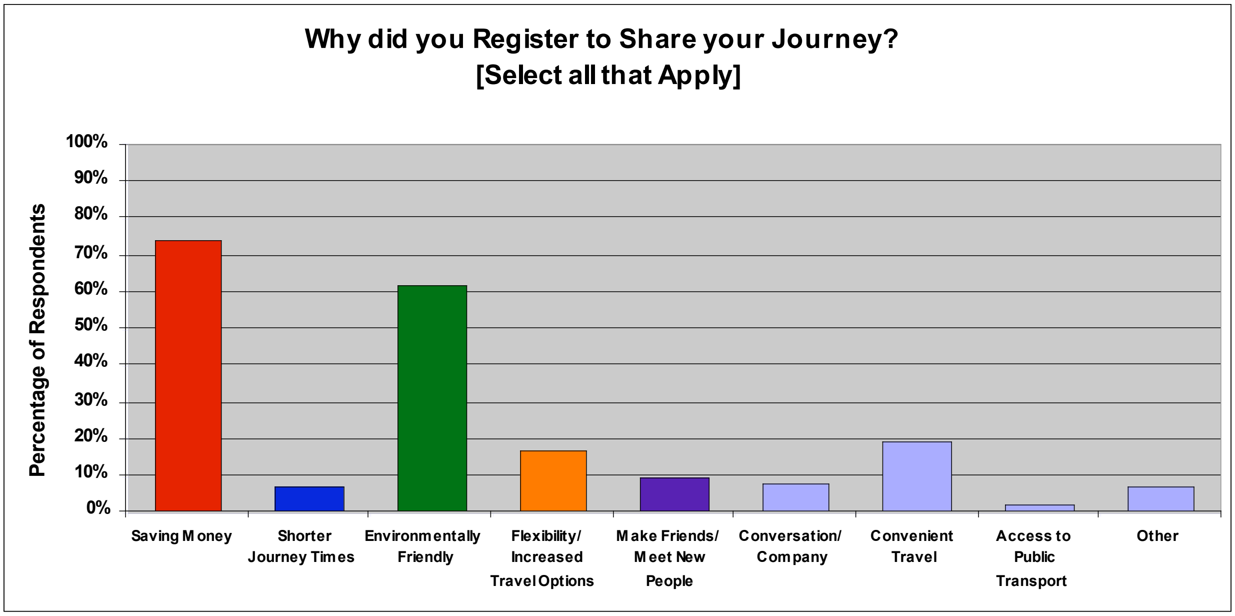
Chapter 2 introduced a number of characteristics of the rideshare population. While understanding who is sharing rides is important, the statistics do not always indicate why individuals choose to rideshare. This section reviews previous survey data explicitly asking why rideshare participants choose to share rides, and modeling efforts to understand what specific characteristics of ridesharing are most appealing to participants.

Research into rideshare participant motivations was first explored in the 1970's, at the same time that rideshare research was gaining popularity. In a study by Tischer and Dobson (1979), a sample of 340 home interviews of SOV commuters that traveled to the Los Angeles central business district were analyzed to determine what factors were most likely to attract SOV commuters to alternate modes, namely bus and ridesharing. Interestingly, the strongest predictor of mode shift to either bus or ridesharing was the perceived convenience of bus transit. Other rideshare specific factors that influenced mode shift included schedule flexibility, cost savings, rider safety and travel time savings (Tischer & Dobson, 1979).

More recently, Li et al. (2007) analyzed approximately 4,600 Internet-based rideshare surveys from respondents in Dallas, TX and Houston, TX to determine the predominant reasons for sharing rides. Participants were given a series of reasons for sharing rides and were asked to rank the importance on a scale of one to five. Sharing vehicle expenses and travel time savings received the highest and second highest number of votes, respectively, however both had bi-polar distributions, with participants stating that they were either very important factors or were not at all important. Those participants that stated that shared vehicle expenses and travel time savings were very important were largely sharing rides for commuting trips, while participants that stated that those reasons were not at all important were largely sharing rides for 'other', non-commuting purposes. Enjoyment of social interaction and decreased environmental impact were the third and fourth most selected reasons, respectively, for sharing rides and had relatively uniform distributions across the five ranking categories. Once again, there were statistically significant differences based on trip purpose. Those sharing rides for commuting trips ranked environmental concerns much higher than those undertaking 'other', non-commuting trips. Conversely, those undertaking 'other' trips ranked enjoyment of social interaction much more highly than commuting trip participants did. The highest ranked reasons for sharing rides for commuting trips were travel time savings and shared vehicle expenses, whereas the highest ranked reasons for sharing rides for 'other', non-commuting trips were relaxation while traveling and enjoyment of social interaction (Li et al., 2007).

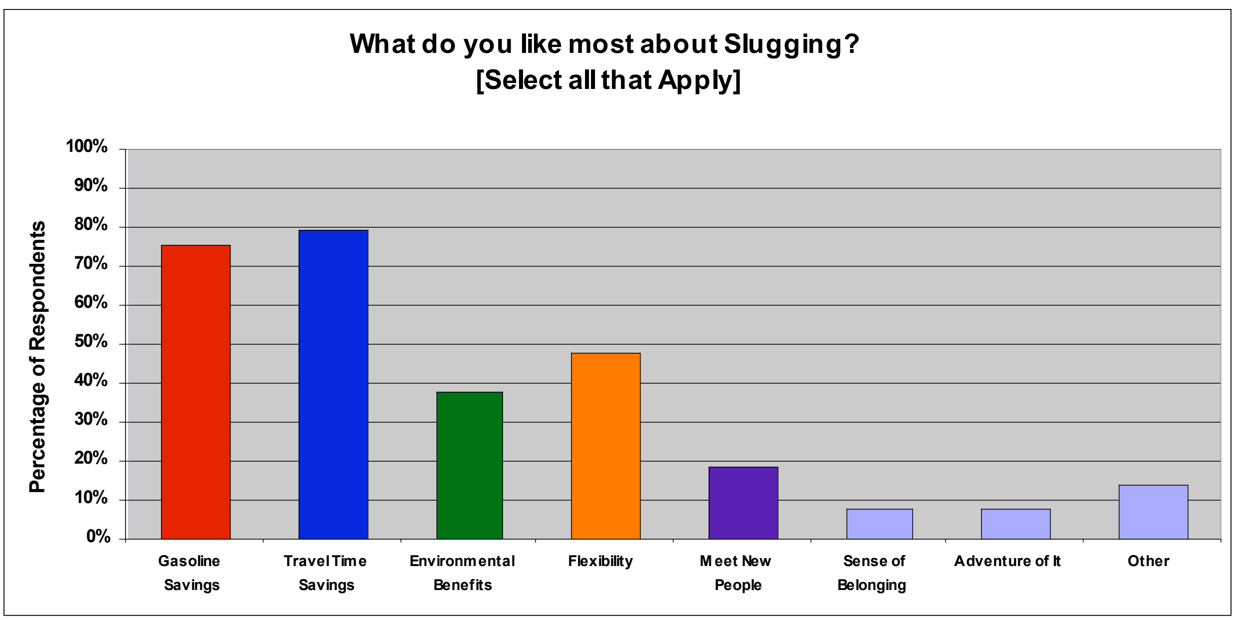
Geographic differences in motivations are particularly interesting to consider. Two recent surveys, one from the UK and one from the 'slug lines' in the Washington, DC region highlight some of the different motivations for ridesharing. 'Slug lines', or casual carpooling, is a phenomenon whereby drivers and passengers pair up on a daily basis for single trips, in order to obtain substantial travel time savings from the use of the I-95/I-395 HOV lanes. While administered independently, both surveys asked a similar question regarding the motivation to share rides and both had relatively similar choices that respondents could choose from. The results, displayed graphically in Figures 3.2 and 3.3, show important geographic variations in rideshare motivation. In the Washington, DC survey, travel time savings and travel flexibility were deemed to be much more important motivators than in the UK. Environmental friendliness was a much stronger motivator in the UK survey than within the US casual carpool community. Cost savings were a major motivator in both the US and the UK, with over 70% of respondents identifying that factor in the surveys (Oliphant, 2008 / Clabburn, 2009).

**Figure 3.2: LiftShare.org UK 2008 Survey - Motivations of UK Membership**




Source: Clabburn, 2009

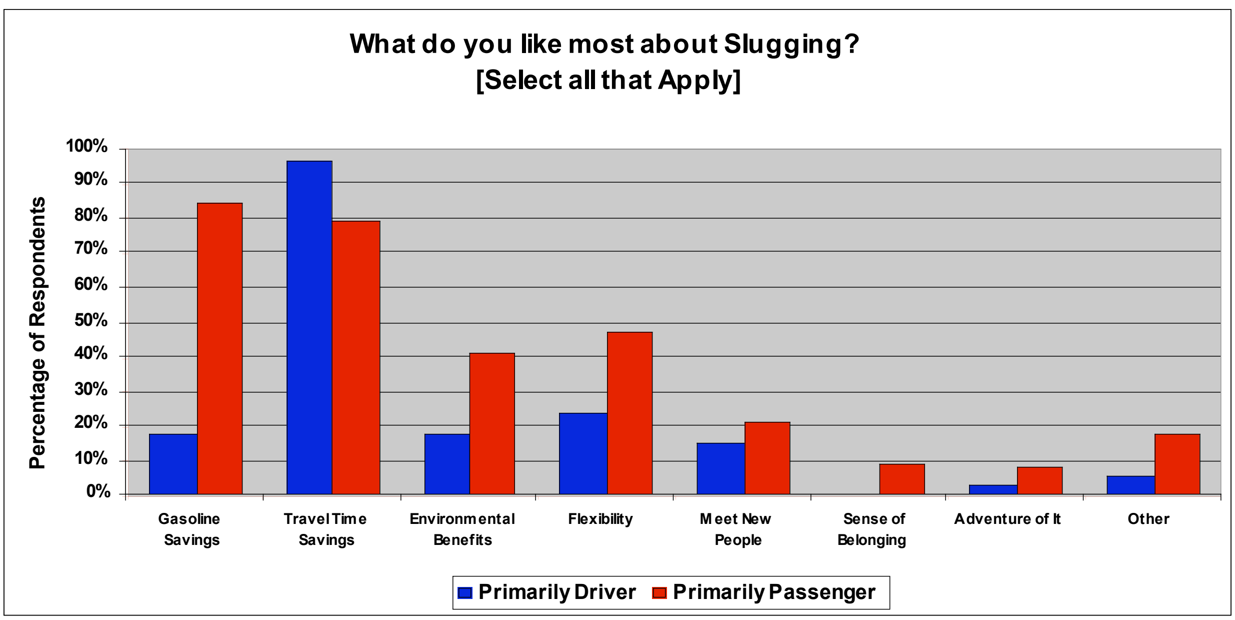
**Figure 3.3: Marc Oliphant 2008 Survey - Motivations of Washington, DC Slugging Participants**




Source: Oliphant, 2008

The differences in motivations for drivers and passengers in rideshare arrangements has not received much attention in the literature. The Washington, DC casual carpool survey asked respondents to identify their role in shared ride arrangements as primarily driver, primarily passenger or both (Oliphant, 2008). Analyzing the motivational responses, but splitting them into driver and passenger categories, reveals some very interesting trends. The analysis is presented in Figure 3.4. For drivers, the largest benefit by a large margin is the travel time savings from the use of the High Occupancy Vehicle (HOV) lanes. For passengers, it appears that the motivations to slug are more diverse, with cost savings and travel time savings remaining the most important factors, but flexibility and environmental benefits ranking strongly as well (Oliphant, 2008). These results should be regarded cautiously, as the slugging arrangement in Washington DC is rather unique and cannot easily be replicated elsewhere. If the travel time savings from HOV lanes did not exist, would drivers perceive the remaining benefits to be sufficiently large to continue picking up unknown passengers? Alternatively, in settings where substantial HOV infrastructure does not exist, what is the main incentive for a driver to share a ride, and can other types of benefits be introduced to entice drivers to participate? These are relevant questions given that most locations in North America do have the same corridor characteristics as those found along the casual carpool corridor in Washington, DC.

**Figure 3.4: Marc Oliphant 2008 Survey - Motivations Split by Rideshare Role**




Source: Oliphant, 2008

Motivations to share rides differ by geographic region, by trip purpose and by role in the rideshare arrangement, as several surveys in this section have demonstrated. It is more than likely that each rideshare participant chooses to share rides for a slightly different set of reasons, and if those reasons can be understood, customized marketing and incentive schemes can be developed. The final section of this chapter will review the important influence incentives have had on some previous transportation initiatives and will present some innovative incentive and marketing efforts that may be applicable to ridesharing.

## 3.3 The Importance of Incentives, Marketing & Promotion

The provision of incentives to encourage ridesharing is not a new concept; employers, public agencies and most recently private providers of rideshare services have come to realize that they are increasingly important in encouraging travelers to try transport alternatives. Literature on the impact of incentives will be reviewed and several innovative incentive schemes will be highlighted. Of course, encouraging participation through the use of incentives is contingent upon individuals knowing that ride sharing is a viable option for them. Marketing and promotional efforts have an important role to play informing passengers that they have the option to change their travel behavior. This section will also review recent marketing initiatives that have encouraged greater use of alternative modes.

### 3.3.1 The Importance of Incentives

Hwang & Giuliano (1990) undertook a comprehensive review of the determinants of rideshare participation, including the influence of incentives, after the passage of Regulation XV in the Los Angeles region. Resolution XV mandated that employers with 100 or more employees significantly reduce AM peak-period trips. Employers were required to submit annual plans outlining how they planned on reducing AM trips and were required to employ a designated rideshare coordinator. The research hoped to provide information to employers on which techniques were most successful at encouraging employees to use alternate modes of transport. The review found that financial incentives (free meals, prize drawings) were more effective at changing behavior than ‘convenience’ incentives (preferred parking, guaranteed ride home) were. The experience of the Tennessee Valley Authority (TVA) was cited as a particularly successful example. After they started operating free express buses and vans for employees, and offering carpools subsidies, the TVA saw their SOV commuter share drop 12% immediately. Between 1973 and 1979, they saw their SOV mode split decrease from 65% to 17%, although it is worth noting that this timeframe covered the span of both of the 1970’s energy crises. The review also found that employer-subsidized or employer-paid parking was the single largest inhibitor of ridesharing (Hwang & Giuliano, 1990). The Hwang and Giuliano review concluded with the following, rather appropriate quote:

> “The more effective strategies appear to be those that significantly affect the relative cost or convenience of solo driving. Thus, imposing parking charges on employees who previously had free parking, or providing cash subsidies for transit or vanpools equivalent in value to the parking subsidy will have a significant impact, whereas providing preferential parking for carpoolers and vanpoolers will have little effect, since it does not substantially reduce relative inconvenience of ridesharing.” (Hwang & Giuliano, 1990)

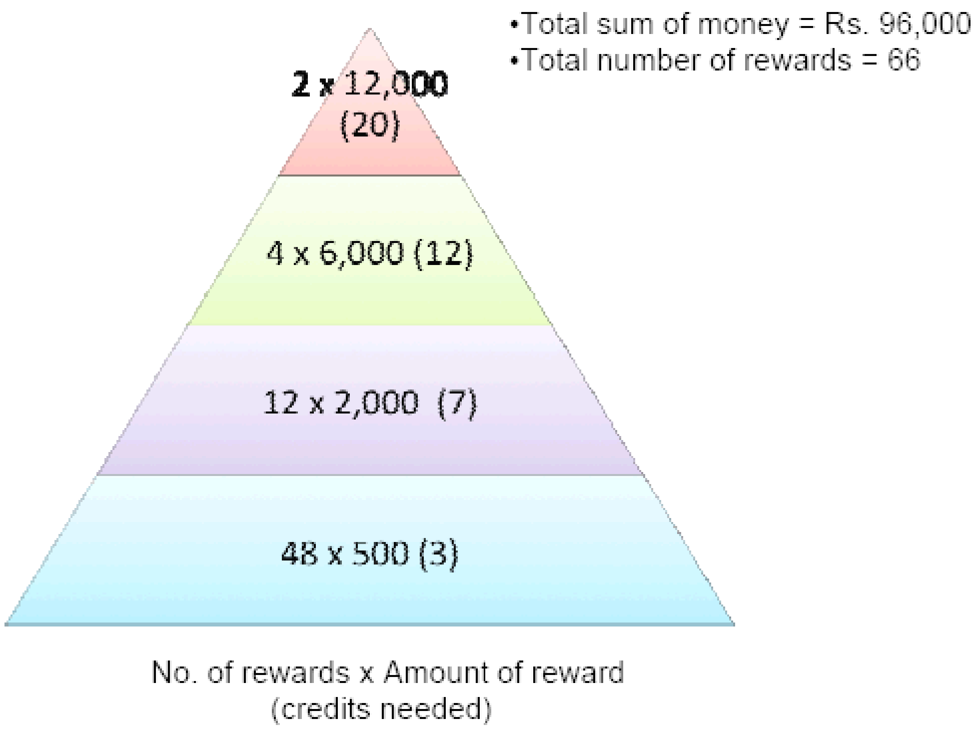
The first part of this quote highlights an important economic concept known as ‘loss aversion’. Research has shown that individuals much prefer avoiding losses than acquiring similar sized gains (Kahneman & Tversky, 1979). This concept suggests that actions such as increasing parking charges for SOV drivers would be more effective at encouraging behavior change than giving ride share participants the same amount of money as cash. Politically and institutionally, however, it is often more difficult to raise parking fares for a large group of individuals than it is to simply offer incentives to a much smaller group of individuals.

Following from the discussion in the previous paragraph, public agencies have more recently begun experimenting with the provision of cash incentives for commuters. One of the first organizations to try this was Atlanta’s Clean Air Campaign. In 2003, the Cash for Commuters program offered commuters a reward of $3 a day for every day that they used a commuting alternative (transit, carpool, vanpool, telecommute, walk, bike or compressed work week) to get to work (Center for Transportation & the Environment, 2004). The incentive was offered to travelers for a 90-day period. Participants in the trial had to have previously been an SOV commuter. Follow-up surveys indicated that 74% of participants continued to use a commute alternative 3-6 months after they stopped receiving the cash incentive. At 9-12 months after the rewards ceased, 64% continued to use commuting alternatives (Center for Transportation & the Environment, 2004). Due to the program’s perceived success, it has been copied elsewhere including the 511.org ‘Rideshare Rewards’ program in the San Francisco Bay Area (MTC, 2006) and the recently announced Commuter Connections ‘Pool Rewards: Cash for Carpools’ program in the Washington, DC area (MWCOG, 2009).

Historically, employers and public agencies have been the institutions that have offered incentives, largely because they have had the financial resources to do so. However private providers of rideshare services have recently begun to offer their own incentive schemes. NuRide, a private firm, is the nation's largest provider of rewards for those that choose sustainable forms of transportation (carpool, vanpool, public transit, cycling, walking and telecommuting) (NuRide Inc., 2010). NuRide participants accumulate points based on the number of non-SOV trips they take. Those points can be redeemed for a variety of discounts at popular local businesses and events. NuRide targets specific metropolitan areas and will only advertise rideshare opportunities if they can offer participants a variety of rewards (NuRide Inc., 2010).

The literature has more or less shown that rideshare incentives are an important tool in encouraging shifts in mode choice. Yet there are still many questions about the impact of incentive schemes on traveler behavior. For example, current programs tend to reward travelers on an on-going basis or provide a large reward after a fixed period of time, say 90 days. Rather than providing many small guaranteed rewards or one large guaranteed reward, Prof. Balaji Prabhakar with his team at Stanford University undertook an innovative incentive trial that resembled a weekly raffle, with the size of the prizes and the odds of winning those prizes larger for those that modified their behavior more (Prabhakar et al., 2009). The idea behind the trial is that small rewards are insufficient to effectively encourage substantial, positive behavior changes. But a system that pools small rewards and offers a small number of large awards frequently through a raffle process are more likely to affect behavior change. The trial design employs an economic concept known as 'risk seeking', whereby certain individuals are more likely to accept the chance of winning a large reward than accepting a smaller, but guaranteed reward, even if the expected value of the two sets of awards are the same. The trial was aimed at modifying the travel behavior of bus commuters traveling to and from an Infosys Technologies, Inc. office located in Bangalore, India. In the trial, commuters that took the bus during less congested periods (when bus capacity was available and not constrained) received credits. At the end of the week, commuters were placed in groupings based on how many credits they had accumulated. The small group of travelers that changed their behavior significantly during the week were entered into a draw for two, 12,000 rupee (~$250) awards (Prabhakar et al., 2009). In general, the probability of winning was high because the number of people that changed their behavior significantly was small. The somewhat larger group of travelers that changed their behavior to a lesser degree were entered into a draw for four, 6,000 rupee (~$125) awards. In total, four tiers of rewards were available to participants. In general, the more credits a commuter accrued, the higher the reward amount they could win and the higher the chance that they would win an award in a given week. The 'Reward Pyramid' describing the four tiers of rewards is show below in Figure 3.5. The Bangalore trial led to a doubling of travel during less congested periods and a 24% decrease in overall average travel time for ***all*** bus commuters within the firm. The change in behavior was so substantial that Infosys was able to eliminate several buses from service, with the cost savings of doing so more than covering the cost of providing the incentives (Prabhakar et al., 2009).

**Figure 3.5: Prabhakar et al. Incentive Pyramid, Infosys Trial in Bangalore, India**




Source: Prabhakar et al., 2009

The design of the Bangalore trial could be applied to ridesharing incentive programs, with several modifications. While the Bangalore trial was interested in encouraging shifts in travel times, the goal in a rideshare program is modal shift, which may require a larger sacrifice on the part of commuters and thereby require larger overall incentives. In the MIT case, the goal may not be to encourage each community member to significantly change their behavior (ie: rideshare five days a week), but rather share rides two or three times a week consistently. To encourage this, the reward pyramid could be designed with fewer gradients, but higher rewards in later weeks if behavior change remains consistent over time. If some participants are found to be risk averse, small daily discounts at local establishments could be provided to them in lieu of the award raffle. Perhaps the most difficult aspect of applying this incentive scheme would be the accurate measurement of shared rides. The Bangalore trial measured employee time of travel based on the time employees first used their access card to enter the office building. In MIT's case, there is currently no method of identifying when a community member has driven alone or shared a ride to campus. Rideshare measurement will be discussed further in Chapter 8.

### 3.3.2 The Importance of Marketing & Promotion

Marketing and promotion of rideshare initiatives go hand-in-hand with the provision of incentives. Historically, marketing of rideshare initiatives has been 'top-down'; aimed at large portions of the population and generic in its message. The WWII promotional posters presented in Chapter 2 are a good example of this. Yet much of the recent research suggests that 'bottom-up' (targeted and personalized) marketing may be more effective an encouraging substantial travel behavior change in a smaller population. The studies below suggest that targeted, personalized marketing campaigns that engage participants consistently and provide feedback about their travel decisions may be an effective way of encouraging the use alternative modes of travel.

In their book "Nudge", Thaler and Sunstein (2008) highlight two challenges associated with personal transportation decisions; the salience of transport options, and a lack of feedback. Because commuting trips are a habitual activity, commuters rarely stop to consider what other options are available to them, absent a massive shock such as a substantial increase in fuel prices or the loss a transport facility. Further, even if commuters desire information on alternative transportation options, it is often not communicated in a way that allows travelers to effectively evaluate cost, travel time and environmental trade-offs. Second, travelers generally only receive 'feedback' on the choices they have made, not on those that they have not made. For those travelers that do not experiment with different travel options, there is very little opportunity to receive feedback and determine the relative value of alternative modes (Thaler and Sunstein, 2008). The authors believe that incorporating information tailored to the individual traveler, combined with encouragement to try different modes will lead to better travel decisions.

One attempt to test the impact of traveler-specific information combined with feedback on travel choices was a series of trials conducted by Rose and Ampt (2001) in Sydney and Adelaide, Australia. The initiatives, referred to as 'Travel Blending', provided households with four travel information packages over the course of nine weeks. The initial package asked participants to record their travel behavior over the course of two weeks in a travel diary, and the second package provided personalized feedback on methods of reducing auto use. Participants were given several weeks to try the recommendations, at which point a third package was sent asking participants to fill out another travel diary. After the difference between the two travel surveys was analyzed, a fourth package was provided to participants summarizing the travel and environmental impacts of their behavior changes. While the initial number of participants was small (approximately 100), the test found that after receiving personal travel information and feedback, household VKT was reduced by 11% and auto trips were reduced by 13% (Rose & Ampt, 2001).

Cleland (2000) developed a study in the US based on the initial results of Rose and Ampt's study. In Cleland's study, a group of 75 individuals from the same organization (a YMCA in Tampa Bay, FL) were split into two groups, a control and an experimental group. Both groups were asked to track their travel over a course of seven days using a travel diary. At the end of the week, the diaries of the experimental group were analyzed and personalized feedback on their initial travel choices was provided. Those in the control group received no feedback. Several weeks later, a second seven-day diary was administered and analyzed. Using analysis of variance techniques, Cleland found that the difference in auto trips and VMT between the experimental and control groups were statistically significant, suggesting that the provision of travel information and feedback did have an impact on behavior (Cleland, 2000).

More recently, the City of Portland, Oregon has administered an annual program called "SmartTrips", aimed at providing information on alternative travel options (Portland Office of Transportation, 2007). Each year, a different part of the metro area is selected. While specific households are not targeted, those that respond to the general marketing materials are sent customized information including transit schedules for the routes nearest their house, bike and walking maps, information on cycling information sessions in their neighborhood, etc. A number of "SmartTrip" events are also organized such as 'Senior Strolls' (guided walks for senior citizens to local commercial areas) or bicycle commutes led by long-time cyclists. In the most recent two years (2006 & 2007), nearly 30% of households in the target areas have requested information or participated in a "SmartTrip" event. Travel diary analysis and before-and-after telephone surveys for five years of "SmartTrip" initiatives between 2003 and 2007 have estimated auto trip reductions in the 9-12% range (Portland Office of Transportation, 2007).

Customized travel information, along with traveler feedback and a well-designed incentive program has the potential to lead to significant changes in travel behavior. The uses of these techniques and how they could be used to encourage alternative modes of travel within the MIT and Cambridge, MA communities will be discussed in Chapter 8.

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## Chapter 4: Rideshare Stakeholder Perspectives

Thus far, much of the focus of this thesis has been on the ‘demand side’ of ridesharing; understanding the characteristics and behavior of rideshare participants. This chapter presents a ‘supply side’ perspective of ridesharing, based on a series of interviews undertaken with rideshare stakeholders, including private service providers, public agency providers and several large employers. A total of fifteen interviews were undertaken; nine with private providers, four with public sector agencies and two with large employers. As the distribution of interviewees suggests, the focus of these interviews was largely service provider focused. The purpose of these interviews was to allow leaders in the provision of rideshare services to describe what they perceived as the largest rideshare challenges to be overcome. These interviews informed the organization of the “Real-Time Rides Workshop”, held at MIT in April 2009 that many of the interviewees subsequently attended. The workshop brought together approximately 40 participants from five countries to discuss some of the specific challenges highlighted in the interviews. This chapter will summarize the viewpoints of each group of stakeholders and will conclude with common perspectives across all of the groups.

The term ‘rideshare service provider’ is used throughout this chapter and is described before proceeding into a summary of the interviews. There is no formal definition of what a rideshare service provider does, or what package of services they offer. All rideshare service providers employ a database with some form of computer “matching” algorithm that pairs drivers with passengers. For some, this matching functionality with a simple Web-based interface constitutes a ‘rideshare service’. Nearly all providers engage in some form of marketing or advertising. Many of the more innovative providers have expanded their businesses to include other value-added services. A subset of providers focuses almost exclusively on large organizations and helps those firms develop customized commuter information services for their employees. The innovative providers have also begun to challenge traditional methods of communicating rideshare opportunities, by moving their services to smart phones. The geographic level of coverage of rideshare providers tends to be quite varied. Some providers target employers, others focus on specific metropolitan areas or states, and some offer their services to anyone that is interested. The public agency providers tend to be larger than the private providers and generally have greater financial resources available. This allows them to provide incentives and “Guaranteed Ride Home” benefits. The public sector providers may also offer additional services such as vanpool programs, or neighborhood shuttle bus services. In sum, the term 'rideshare provider' refers to those organizations (whether private firms or public agencies) that, at the very least, enable the matching of drivers and passengers to a form rideshare arrangement. In many cases, providers offer an array of travel services beyond participant matching.

## 4.1 Private Provider Perspectives on Ridesharing

Nine private providers of rideshare services from four different countries were interviewed. Nearly all of these providers were small, technology-based firms employing fewer than five employees. The providers were relatively new to ridesharing, with few having operated for more than five years. Many of the challenges highlighted by this group could be linked to the challenge of identifying a successful rideshare business model. Generally, three business models have been attempted:

(1) the provision of fee-based rideshare services targeting all interested participants,

(2) the provision of fee-based rideshare services targeting public agencies (who then offer services to all interested participants in a geographic area [metro area or state] and/or to targeted organizations), and

(3) the provision of fee-based rideshare and commute trip management services to organizations, typically large employers.

Those services that target all interested parties generally rely on advertising or marketing revenue, or they receive a percentage of a successfully matched trip's transaction value. Services provided to public agencies will differ in their specific terms, but often involve an initial payment for the installation of a rideshare software package and may involve ongoing payment for additional support services. Those targeting large employers often rely on a similar model; an initial payment for a customized software package may be supplemented with additional payments for supporting services.

These three business models target vastly different sized groups of rideshare participants. If we assume for the moment that most providers target work commuters, then estimates can be limited to employees rather than the population at large. Those providers that allow all interested participants to sign up for their services have the largest potential market, effectively the entire US. In the first quarter of 2008, the US had over 112M. employed persons across the country (US Department of Labor, 2008b).

Determining the market size for those providers targeting public agencies is more difficult. If one assumes that every Metropolitan Planning Organization (MPO) and state in the US requires some form of rideshare service, it would imply that approximately 436 (385 MPO's and 51 states, including DC) unique systems would be needed. It is not clear how accurate this estimate really is. Several states only provide statewide matching services, suggesting this value is overstated. However, some regional organizations such as TMA's will provide their own local or regional rideshare services, suggesting the estimate is understated. In the case of Massachusetts, MassRides is the public agency in charge of promoting ridesharing statewide. In 2008, Massachusetts had nearly 2.8M. employees across the state (US Department of Labor, 2008b). If MassRides were to limit their efforts to the Boston metropolitan area only, they would still be targeting approximately 2.5M. employees (US Department of Labor, 2008b).

Providers targeting only large employers are focusing their efforts on a rather small group of employees, but those that are the most likely to share rides. The first complication in targeting 'large' employers is determining what constitutes 'large'. Although little evidence exists on how many participants are needed to reach critical mass, this author will suggest that targeting firms with greater than 500 employees would be a reasonable place to start. A further complication that arises is the distinction between firm size and establishment size. McDonald's, for example, is a massive firm with hundreds of thousands of employees across the US. However, these employees work at 13,000 different establishments, with no restaurant employing more than several dozen people. For the purposes of ridesharing, the size of the ***establishment*** is more important than the size of the ***firm***. According to the US government, there were over 16,000 establishments with 500+ employees in the US, employing nearly 19M. people, or 17% of the US workforce (US Department of Labor, 2008b). In Massachusetts, there were 411 establishments with 500+ employees, employing nearly 535,000 people, or 19% of the state workforce. Figure 4.1 below summarizes the relative size of the markets (US Department of Labor, 2008b). If it is assumed that many of these large establishments are located in central business districts, or in suburban business clusters where some reasonable level of job density is assumed, there may be opportunities to expand rideshare opportunities to neighboring organizations. If these employees were included, the size of the potential pool of rideshare participants could conceivably increase 50-100%, although there is no quantitative data to support this belief. This would imply that approximately 25-30% of US employees and 30-35% of Massachusetts employees could share rides.

**Figure 4.1: Total Estimated Market Size for Different Rideshare Business Models, 2008**

| Total Estimated Market Size for Different Rideshare Business Models | | |
|---|---|---|
| | USA | Massachusetts |
| Business Model #1: Nationwide - Total Employment | 112,661,107 | |
| Business Model #2: Statewide - Total Employment | | 2,781,943 |
| Business Model #2: Boston Metropolitan Area - Total Employment | | 2,503,720 |
| Business Model #3: Establishments >500 Employees | 16,336 | 411 |
| Business Model #3: Establishments >500 Employees - Employment | 18,853,263 | 534,047 |
| Establishments >500 Employees - % of Total Employment | 16.7% | 19.2% |

Source: US Dept. of Labor, 2008b

### 4.1.1 Need to Reach a Critical Mass of Participants

Every private provider that was interviewed identified the lack of a “critical mass” of participants as a large underlying problem for ridesharing. To maintain a sustainable level of interest and participation, drivers and passengers must be able to find appropriate matches when they need them. If a potential participant seeks a rideshare match multiple times without success, they begin to lose interest and are less likely to seek rides in the future. Several providers acknowledged the importance of incentives and overcoming behavioral obstacles, and a small number believed that targeting employers was necessary to encourage greater participation. Other providers believed better marketing and technology improvements would be sufficient to overcome this challenge.

In this author’s opinion, a lack of critical mass is a symptom of the rideshare challenge rather than an underlying cause. In clearer terms, the lack of interest in rideshare arrangements is better explained as the inability to effectively address poor cost, convenience, reliability and safety perceptions held by travelers, rather than an inherent problem with ridesharing itself. If providers are intent on reaching a critical mass of participants, a stronger understanding of traveler motivations and concerns is certainly needed, along with a comprehensive plan that includes targeting employers, marketing to specific travelers and providing incentives.

### 4.1.2 Strong Technology & Social Networking Focus

In the process of creating their ridesharing services, many providers have focused heavily on providing access to their services through mobile devices such as smart phones. Historically, providers have had a strong web presence where potential participants could log in from a desktop or laptop computer and view potential partners. Many of the private providers have created customized applications that now allow the public to use their services from a smart phone or other mobile device. With services operating on mobile devices with built in GPS, participants save time by no longer needing to provide their current location when searching for matches.

Providers have realized that it is difficult to encourage shared rides between strangers because of safety concerns. In an effort to move beyond this challenge, many providers have linked their rideshare services to existing 'social networks' in the hopes of encouraging rides between participants that know each other. In practice, 'social network' integration has mainly been accomplished in one of two ways; providers have embedded their services with online groups such as 'Facebook', or they have focused on offering services to a specific organization or institution. By linking services to 'Facebook'-type groups, only friends within a given individual's immediate social network will be considered when searching for ride matches. In instances where employers have been targeted, only co-workers at the same organization are considered as potential partners. For the small number of providers where social network integration had not yet been achieved, all had intentions of including a social network feature in the near future.

### 4.1.3 Behavioral Concerns Understood, No Consensus Approach on Overcoming Them

Virtually all providers understood that concerns such as a fear of strangers and a lack of economic value were inhibitors to greater rideshare participation, but there was little consensus on how to overcome these barriers.

Nearly all providers had tied their services to some form of social network (as described previously) to encourage rides between friends and co-workers.

Technology-based solutions have been proposed that would use the GPS capability in a mobile phone to track passengers until they reached their final destination. By comparing the expected route that the driver and passenger had agreed on to the real-time GPS trace, the service provider could identify shared rides that were not heading towards the agreed upon destination and a message could be sent to the passenger asking for confirmation that this was acceptable.

Some providers thought that an 'eBay'-style participant rating system would reduce the anxiety of sharing rides with unknown individuals. After a ride has been completed successfully, both the passenger and driver would be asked to rate each other. The idea behind this feature is that it allows future users to evaluate potential partners quickly, based on others past experiences. Those participants with consistently low ratings would be unlikely to find future rides.

To encourage consistent participation, some providers were offering incentives for every ride undertaken. Others felt it was easier to target universities and large organizations where participants have a common place of work or study, and might be more willing to accept rides from unknown individuals within the same organization. Providers were considering multiple strategies to overcome behavioral barriers, but no single provider was considering all of the strategies outlined above.

### 4.1.4 Wide Range of Views on the Importance of Incentives

One of the most surprising findings from the interviews with private providers was the range of opinions on the importance incentives. Several providers believed that incentives were absolutely critical to successful rideshare service provision. Given that individuals were not currently choosing to rideshare, there was a belief that additional benefits were needed to encourage changes in behavior.

A variety of incentive types have been used in the past. Discounts and gift certificates have been popular. Some providers are experimenting with lottery systems, under the assumption that a large reward is more likely to attract participants than many small awards. Those providers working with large employers have occasionally been successful at setting aside a number of preferred parking spaces for rideshare vehicles. Others felt that the provision of incentives would be helpful, but that better marketing and technology enhancements that would allow their services to “go viral” were of greater importance.

A further subset believed that transactions between participants, whereby passengers pay drivers for the ride, would be a large enough incentive to encourage widespread participation.

### 4.1.5 Different Business Models Dictate Interest in a Common Data Specification for Sharing Information

The choice of a rideshare business model substantially influences provider perspectives on the need for a common rideshare data specification, an agreed upon method of recording participant information and rideshare trip characteristics in a database, which enables users to search multiple provider services simultaneously. An underlying data specification is what allows services such as Expedia and Kayak to search multiple airline databases simultaneously.

Those providing services to the general public, and some providers of services to public agencies, thought a common specification for communicating rideshare opportunities was important and valuable. The need for a common data specification is based largely on the fact that multiple providers offer services in the same geographic area. In general, it’s unlikely that a rideshare participant is going to register and search for rides using multiple services, so the specification allows for searches of multiple systems

simultaneously. Since many of these providers rely on the recruitment of a large number of participants, the increased visibility brought about by a common standard was viewed favorably.
For those mainly targeting large employers, there was less interest in a common specification. Employers will generally only contract with a single rideshare service firm, so there is rarely if ever multiple services that need to be searched simultaneously. It was believed that large employers would not necessarily be interested in allowing people outside their firm to see what rideshare opportunities they had available, further reducing the need for a shared specification.

The provider's choice of business model also determined the perceived need for multi-modal information integration, however there was a more widespread belief that in this case a common standard would be of value. Many of the providers recognized that travelers rely on multiple modes of transportation, yet rarely have information on all of those modes easily accessible. There was a rather widespread belief that information on all modes of transportation would be valuable in helping travelers make better decisions, and that particularly in cases when a rideshare option was unavailable, this information would help travelers identify other travel options. Several providers targeting the general public were ambivalent towards the provision of multi-modal information, but they constituted the minority. Most providers, particularly those offering comprehensive commuter services to public agencies or large employers, were strongly in favor of multi-modal information integration.

### 4.1.6 Concerns about Appropriate Roles for Public and Private Sector Providers

Some of the providers were concerned about the roles of the public and private sector in the provision of rideshare services. Many private and public sector services target participants in the same geographic areas (a given metropolitan area, for example), leaving some private providers feeling that public sector services were intentionally competing with them for participants. Some providers felt that the public sector should allow private providers to bid for regional ridesharing services thereby allowing competition, but avoiding fragmented service offerings in a geographic area. Others felt competition within a given geographic market was acceptable, but hoped that a common data specification could be agreed upon so that multiple services could be searched simultaneously.

Certain providers, namely those offering services directly to large employers, were less concerned about the public sector's role. Given that they were marketing their services to a given organization where competition does not typically exist, these providers were content to continue creating ‘closed’ programs for individual employers.

## 4.2 Public Sector Provider Perspectives on Ridesharing

Four public sector providers were interviewed for their perspectives on ridesharing. The agencies were split evenly between the East coast and West coast of the US. Two agencies were tasked with providing rideshare services statewide, while the other two provided services to large metro regions.

### 4.2.1 Widespread Understanding that Incentives are Critical

All of the public sector providers interviewed believed that incentives were an integral part of rideshare service delivery. There was a general belief that incentives were needed to encourage participation and that the public sector was an appropriate entity to provide incentives to travelers. All providers were using some form of incentive mechanism, and were watching other public agencies around the country to see what incentive packages were working well elsewhere. At the time of the interviews, several of the providers felt that providing direct cash incentives was a successful strategy. This belief was based on results from a trial in Atlanta where commuters were offered a reward of $3 a day for every day that they used a commuting alternative (transit, carpool, vanpool, telecommute, walk, bike or compressed work week) to get to work. The incentive was offered to travelers for a 90-day period. Follow-up surveys indicated that 74% of participants continued to use a commuting alternative 3-6 months after they stopped receiving the cash incentive. At 9-12 months after the rewards ceased, 64% continued to use commuting alternatives (Center for Transportation & the Environment, 2004). The widespread agreement on the importance of incentives within the public sector was in marked contrast to the wider range of opinions expressed by private sector providers.

### 4.2.2 Challenges in Accurately Measuring Rideshare Activity

All of the public sector providers interviewed were required to track various rideshare statistics, but many felt that they were not measuring the most important characteristics of rideshare arrangements. For example, all of the agencies were measuring the number of participants that registered for their service and the number of ride requests and offers being made, however no agency knew the exact number of rideshare trips that had actually taken place. Without this information, reductions in VMT and emission reductions could not be accurately determined. At least one agency was estimating these values using historical factors.

Some of the new technology-based approaches provide options for overcoming this challenge. Those services that use smart phones with integrated GPS have the ability to locate participants at any point along their route. If this GPS route data were provided, it would be possible to examine both participants GPS traces and confirm that a successful trip had occurred. This type of approach has obvious privacy issues that need to be considered carefully.

Ridesharing is often promoted as a method of reducing congestion and environmental impacts, so the fact that these agencies could not measure the effectiveness of their programs in those terms was seen as a challenge.

## 4.3 Large Employer Perspectives on Ridesharing

While the main focus of the interviews was to seek input from 'supply side' providers of rideshare services, two employers were also interviewed for their views on ridesharing. Given the unique size of these institutions (both were very large) and the fact that only two interviews were undertaken, this section will discuss large employer perspectives more generally.

Both of the employers interviewed were very large institutions with an interest in promoting ridesharing, but were struggling to gain support from within their respective organizations. Marketing and promotion of rideshare activities had historically been limited to providing new employees with information on ridesharing, with promotional materials directing employees to a website for further information. One of the institutions has recently begun providing customized, individual commuter information to employees that request it, and the other institution is considering convening focus groups for employees in certain parts of the metropolitan area to inform them of transit options and potential rideshare opportunities.

The importance of incentives in encouraging rideshare participation was understood by both organizations. In particular, parking incentives such as reduced carpool parking rates and preferential parking locations were identified as the most important incentives that the institutions could offer followed by 'Guaranteed Ride Home' benefits. Both institutions offered parking discounts for participants that chose to share rides instead of driving alone.

The interviewees found it difficult to persuade others within their respective organizations that ridesharing should be a transportation priority. The interviewees mentioned that the relatively small size of the current rideshare population and the perceived lack of future potential were hindering making ridesharing a higher priority. As research in Chapter 7 will demonstrate, the potential for increased ridesharing at one of the institutions is actually very good.

Finally, both interviewees were in charge of a large portfolio of transportation services at their respective institutions and found it difficult to keep up with innovations in rideshare service provision. While they remained interested in opportunities to improve their rideshare offerings, other competing transportation initiatives often took up much of their time. Both individuals suggested they would be interested in receiving concise updates on rideshare innovations, suggesting that large employers more broadly might see value in an independent rideshare information center.

## 4.4 Common Perspectives Among All Stakeholder Groups

Although these three stakeholder groups play very different roles in the promotion of ridesharing, there were a number of common views or perspectives expressed during the interview process and at the MIT workshop. These common perspectives should be viewed as areas where collaboration between stakeholder groups could be undertaken.

### 4.4.1 Ridesharing is Motivated Largely by Human Preferences

There was a widespread belief that the decision to rideshare is driven largely by human preferences and perceptions as travelers weigh competing transportation choices. Better technology can increase the attractiveness of ridesharing by improving convenience and safety for participants, but it should not be viewed as being able to single-handedly increase rideshare participation. There was a belief that economic considerations, service characteristics and institutional arrangements were as important, if not more important to making ridesharing successful. While private providers were split on the importance of incentives, all of the other stakeholder groups believed that they were an essential element of successful rideshare programs.

### 4.4.2 Need for Improved Rideshare Data & Behavioral Research

A large number of the interviewees believed that additional rideshare data was needed, particularly data on the number of shared rides undertaken, and an estimate of rideshare viability in a given market or location. Technology innovations should allow for more accurate determination of successful rideshare trips, but data privacy issues will need to be addressed. Specific behavioral research needs include further understanding of the motivations that underlie rideshare and non-rideshare participants' travel decisions, how specific types of incentives influence travel decisions, and how travelers respond to changes in exogenous variables such as the price of fuel.

### 4.4.3 Provide Multi-Modal Travel Information

Many interviewees saw the integration of rideshare service information with other modal information, such as scheduled and real-time transit information, as essential to improving rideshare participation. It was believed that a true multi-modal system would give travelers more opportunities to participate in ridesharing. While support for a common data specification for sharing rideshare information between providers was of interest to some, there was a strong sense that the most compelling reason for a common data specification was the ability to integrate information on multiple modes of transportation.

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# Chapter 5: The 'Rideshare Challenge' from Multiple Perspectives

This chapter is largely a compilation of findings from Chapters 2, 3 & 4. Through a historical review of successful periods of rideshare participation, a review of previous technology-enabled trials and a series of interviews with rideshare stakeholders, a variety of challenges inhibiting greater rideshare participation have been identified. This chapter will present the 'rideshare challenge' from a variety of perspectives.

## 5.1 The Rideshare Challenge – Ridesharing's Economic Barriers

The economic challenges associated with ridesharing can be broken into two distinct categories; the economic barriers associated with ridesharing specifically, and the favorable economics of single-occupant, private vehicle travel. The poor economics of ridesharing will be discussed first.

### 5.1.1 Economic Distortions Discourage Participation

Although perhaps better characterized as the 'favorable economics of all other modes', subsidies for employer-paid parking, transit, vanpooling and most recently cycling has created a distinct disincentive to share rides. While the federal government has largely been responsible for creating these economic distortions and has shown no interest in eliminating them, many employers and employees benefit from the subsidies, making them even more difficult to eliminate. By allowing employers to offer employer-paid parking and pre-tax transit benefits to employees, these firms avoid paying corporate tax on those benefits. If employees were forced to pay full-cost for their parking or transit, those expenses would be paid using after-tax dollars, thereby reducing disposable income. Given that these economic distortions are not likely to be eliminated, similar tax treatment for those that choose to carpool would begin to increase the desirability of ridesharing.

### 5.1.2 Imperfect Information

Ridesharing suffers from a variety of instances of imperfect information. At the most basic level, drivers and passengers willing to share rides may not have any way of identifying one and other. This challenge has been largely addressed through the development of increasingly sophisticated ride matching systems. However, imperfect information inefficiencies do not stop there. Even if drivers and passengers can be successfully matched, little is known about each individual. What is the driver's driving history? Do either the driver or passenger have a criminal record? Does either the driver or passenger smoke? These information gaps can be important in determining ones likelihood of sharing a ride. Imperfect information can also affect those that do not currently share rides. If a particular driver had not seriously considered sharing rides, but was informed one day that four employees at his organization live in his neighborhood and commute at approximately the same times as he does on a consistent basis, might that encourage him to consider ridesharing for future trips? What if the same driver was presented with the cost and travel times for all commuting options including transit and ridesharing, could that encourage travel behavior changes? The imperfect information challenge is closely associated with some of the social/behavioral and technological rideshare challenges outlined further on in this chapter.

### 5.1.3 High Transaction Costs

High transaction costs are another feature common to many traditional rideshare arrangements. These costs generally take two forms; the time needed to establish a rideshare arrangement, and the additional time needed to pick up and drop off passengers. The amount of effort needed to establish a rideshare arrangement is not insignificant. The creation of a user profile, the search for appropriate matches in a database and the calls and/or e-mails to share information and establish a schedule can be time consuming, particularly if the length of time one plans on sharing rides is unknown. If the expectation is that the rideshare arrangement will be frequent and long lasting (perhaps 6 months or longer), this initial transaction cost may be deemed reasonable. If, however, a participant is only interested in occasional or short-term rideshare opportunities, the initial transaction may be seen as too onerous. Given the complexity of daily schedules and the fact that schedules have significant intra-week variability, it becomes clear that occasional rideshare arrangements are probably more suitable for many people these days, and as such transaction costs need to be reduced to make these types of arrangements desirable. The second form of transaction cost is the time needed to deviate and/or wait for passengers as they are picked up and dropped off. Several academic studies have shown that the majority of drivers are unwilling to incur more than a 5-10 minute delay in order to pick up and drop off passengers, suggesting this is a significant factor in one's perception of rideshare convenience.

### 5.1.4 Assumed Benefits of Ridesharing

Ridesharing is often assumed to reduce congestion and decrease environmental impacts, yet some research indicates that this is not always the case. Morency (2007) found that a portion of the rideshare trips occurring in the Montreal, Canada region were undertaken in order to drop a family member off at work or school, and resulted in a single-occupant, return journey. Additionally, research in the San

Francisco area found that many rideshare participants were previously transit riders (RIDES for Bay Area Commuters, 1999). Generally, those individuals riding transit, cycling or walking should not be targeted for rideshare participation, as they are already using relatively sustainable modes of transportation. Even for those who choose to be a rideshare passenger, there is a question of how their vehicle (if they own one) is used when it remains at home during the day. If the rideshare trip frees up the vehicle for other non-work trips, than the assumed environmental and congestion benefits are at best overstated and at worst negated entirely.

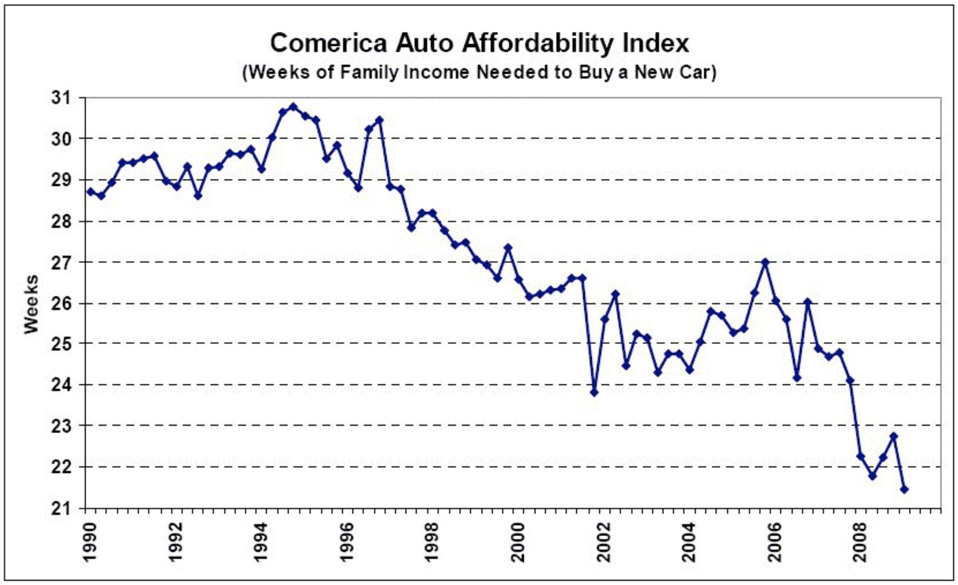
## 5.2 The Rideshare Challenge – Favorable Economics of SOV Travel

While ridesharing suffers from various economic barriers, single occupant, private vehicle ownership and vehicle use continues to capitalize on rather favorable economics. Some of these economic benefits are in the form of hidden subsidies. The current use of the roadway system in much of the western world suffers from tremendous externalities whereby individual drivers make rational decisions in their own self-interest while imposing a multitude of costs on others in the process. These costs include those incurred by other drivers (congestion) and environmental costs (air pollution, emissions). Since these costs are not paid for by users of the roadway system, single-occupant, private vehicle travel is effectively under priced, leading to greater levels of SOV travel than one would otherwise expect to see. Beyond the implicit subsidy for single occupant vehicle travel, there have also been decreases in the real cost of vehicle ownership and use.

### 5.2.1 Decreasing Costs of Vehicle Ownership

The average cost of vehicle ownership has generally followed a downward trend historically. The Comerica Auto Affordability Index, Figure 3.1 below, measures the number of weeks of family income needed to purchase a new vehicle. While the index has been as high as 30 weeks of family income in 1995, it has since decreased to an all-time low of less than 22 weeks of income in 2009 (Comerica Bank, 2009). It should be noted that this chart is only concerned with the average purchase price of new vehicles; it does not include variable costs such as gasoline or insurance, and it does not include the costs of buying a lower-priced, used vehicle instead of a new one. Nevertheless, it highlights the increasing ease of auto ownership.

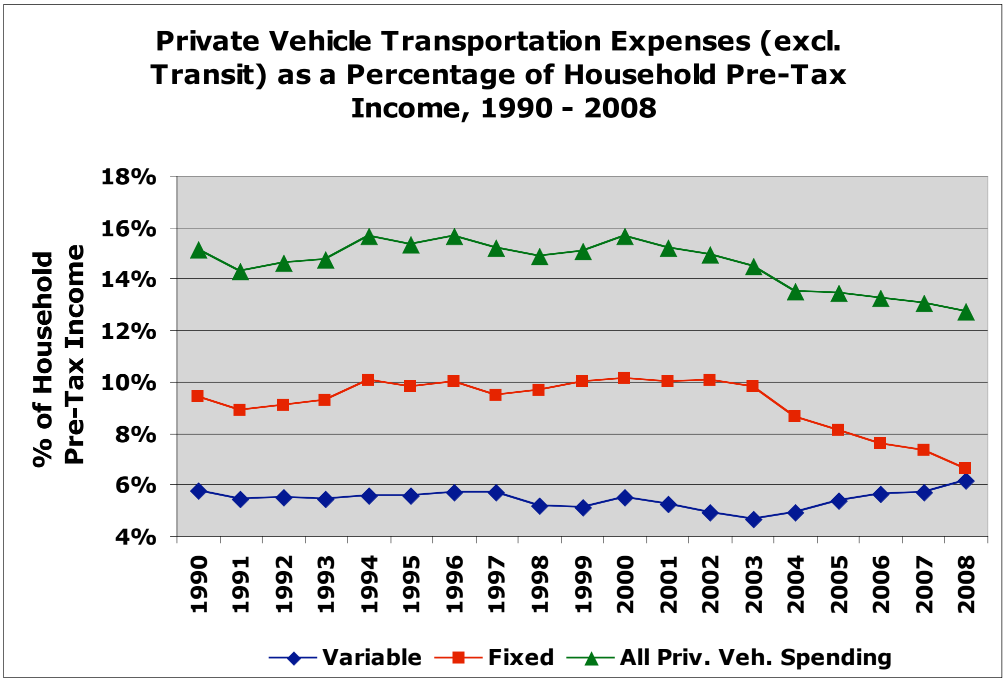
**Figure 5.1: Comerica Bank Auto Affordability Index, 2009**




Source: Comerica Bank, 2009

Note that the decreases observed in the Comerica chart can be explained by some combination of increasing household incomes and/or the decreasing average cost of vehicles. Unfortunately, the chart says nothing about household behavior, namely how households have reacted to overall improvements in auto affordability. Arguably, the share of family income being spent on fixed and variable vehicle costs is of greater relevance. Data from the Consumer Expenditure Survey (CES) displayed in Figure 2.3 below shows that the percentage of income devoted to fixed transportation expenses (such as new car purchases, finance charges & insurance) has decreased noticeably, while variable expenses (such as gasoline & maintenance) have increased only marginally (US Department of Labor, 2008a). Between 1990 and 2008, the percentage of household income spent on "fixed" vehicle expenses decreased from an average of approximately 10% to 6.6%, while the percentage of household income spent on "variable" vehicle expenses increased from an average of approximately 5.5% to 6.2%. Overall private vehicle expenditures as a percentage of pre-tax income decreased from 15.1% to 12.7% (US Department of Labor, 2008a). Both the Comerica Index and the CES show that the relative cost of vehicle ownership for the average American household has decreased over time. Further, as the CES shows, the variable costs of operating household vehicles have remained nearly flat. With decreasing fixed vehicle costs, the barriers to owning a vehicle have decreased, and yet there exists very little incentive to increase vehicle occupancy to offset the rather small increases in variable costs.

**Figure 5.2: Percentage of Household Spending on Private Vehicle Transportation, 1990-2008**




Source: US Department of Labor, 2008a

## 5.3 The Rideshare Challenge – Social / Behavioral

The rideshare challenge can also be characterized as a set of social & behavioral obstacles to be overcome. It should be emphasized that the author views the social and behavioral challenges presented here as rational concerns, but challenges that can be overcome with sufficient safeguards, etiquette and incentives.

### 5.3.1 "Stranger Danger"

It's not uncommon for Hollywood to portray hitchhiking as a common activity, but unfortunately ridesharing between unknown travelers represents but a small portion of the shared rides that take place. Surveys have suggested that as little as 3% to 10% of shared rides occur between unknown passengers, with the rest occurring between family members, co-workers and neighbors. These statistics clearly reflect the phenomenon of "Stranger Danger", whereby drivers and passengers show little interest in sharing rides with strangers because of personal safety concerns.

### 5.3.2 Power Mismatch and the Need for Mutual Dependency

Consider power dynamics in traditional, long-term rideshare arrangements. Drivers typically have greater power to dictate departure time and behavior in the vehicle. Passengers essentially give up their power to participate in the arrangement in exchange for some benefit (cost savings from leaving a vehicle at home, typically). This power mismatch and the perception of unequal distribution of benefits would suggest that traditional arrangements should not be sustainable. In reality, this 'power' mismatch is often overcome by having drivers and passengers alternate driving responsibilities from one day to the next. In effect, drivers and passengers share the power mismatch burden, and share the in the benefits of the arrangement. In casual carpool arrangements, the driver retains the power to leave when they want, but relies on passengers to gain access to the faster moving HOV lanes, or to avoid vehicle tolls. The structure of the system is such that both parties have the power to make the arrangement succeed. Drivers capture travel time benefits while maintaining their freedom to travel when they choose. Passengers capture travel time and cost reduction benefits, but give up some freedom in the process. In both traditional and casual carpool arrangements, it is the mutual dependency and mutual benefit between drivers and passengers that allows ridesharing to be sustained over the long term. The challenge is in identifying opportunities where this mutual dependency exists, and where the power mismatch can be overcome.

### 5.3.3 Reliability of Service

One of the largest behavioral challenges to be overcome is the perception of low reliability in rideshare arrangements. In a typical commuting rideshare arrangement, passengers agree to share rides with a single driver for a period of time, in many cases several months. The driver and passenger agree to a schedule and make small modifications as needed. However, if the driver has an unexpected appointment or emergency, the passenger may be left with no rideshare options for the return journey, a situation that is unacceptable to many commuters. Poor perceptions of reliability are not just isolated to passengers. Drivers that are required to wait for a passenger or modify their schedule substantially to accommodate passengers may have poor perceptions of reliability as well.

### 5.3.4 Schedule Flexibility

The lack of schedule flexibility has been one of the longest running challenges in rideshare arrangements. For rideshare arrangements to last for a reasonable period of time, drivers and passengers often agree to a relatively fixed schedule including arrival and departure times, agreed upon meeting locations and driving responsibilities. This type of arrangement does not allow for much flexibility. Variable work and social schedules can make fixed rideshare arrangements difficult to maintain. It is interesting to note that flexibility and reliability in rideshare arrangements often compete against one and other. This tradeoff will be discussed further in Chapter 6 when the benefits and challenges of real-time ridesharing are discussed.

### 5.3.5 Consistency of Expectations (Vehicle Type & Behavior)

Once drivers and passengers have been sharing rides for a period of weeks or months, they grow accustomed to the routine. The type of vehicle, the condition that it's in, the habits of the driver and passenger, degree of cell phone use, the radio station one has selected, all of these become familiar features or expectations of the commuting trip. This consistency of service is similar to transit in many regards. Transit passengers have a good sense of the type of vehicle that will pick them up, the condition that it will be in, the destination they'll be dropped off at, the behavior of the transit operator and the behavior of fellow passengers. Much of this consistency is due to standardization (of vehicles and driver training), the provision of information (route maps and schedules) and social cues relating to appropriate behavior. One-time or short-term ridesharing arrangements make it difficult for travelers to establish consistent expectations of their commuting trip, and may explain some unwillingness to participate in rideshare arrangements.

### 5.3.6 Lasting Behavior Change

Encouraging a traveler to try ridesharing once is much different from encouraging them to adopt it as one of their regular commuting options. While rideshare services may initially generate strong interest through promotional activities or as a result of external factors such as high gasoline prices, travelers tend to return to previous modes of travel over time unless they perceive strong value in their 'new' travel option. The approach to encouraging lasting behavior change should be to keep rideshare options salient in the minds of commuters and offer benefits that are perceived as having long-term value by participants.

## 5.4 The Rideshare Challenge – Institutional Roles

The institutional dynamics of ridesharing are not frequently discussed, but do impact the mode's attractiveness and success in a substantial way. The majority of the institutional challenges can be distilled down to a question of what are appropriate roles for the private and public sectors in encouraging ridesharing, and which stakeholders are in the best position to capture value and share it with rideshare participants.

### 5.4.1 Insufficient Institutional Collaboration

Private firms that specialize in the development of rideshare matching software and travel management solutions have a key role in reducing transaction costs and providing better information for travelers. Large employers often have the ability to influence travel behavior through the modification of parking prices or by providing benefits for those that choose commuting alternatives. State agencies have a critical role in creating incentives for ridesharing, such as HOV lanes, and developing effective policies to support ridesharing, such as modifications to taxi regulations. The federal government could play a strong role in promoting ridesharing by encouraging a switch to "pay-by-the-mile" VMT-based revenue collection, or by leveling the playing field and allowing rideshare participants to claim the pre-tax transportation fringe benefits that are available to transit and vanpool participants. The challenge lies in encouraging each of these stakeholder groups to collaborate with one and other and take action in those areas in which they have an advantage. Given conflicting goals, resources, power and perceived public mandate it can be difficult for all of these institutional stakeholders to reach a consensus on their respective roles.

The relatively recent introduction of High-Occupancy Toll (HOT) lanes further complicates efforts to establish clear institutional roles in the promotion of ridesharing. HOT lanes effectively allow SOV drivers that would prefer not to be stuck in congestion to "buy" their way into less congested HOV lanes. HOT lanes, which generate significant revenue for public agencies, are gaining some political support as governments seek additional sources of revenue and as suburban and exurban commuters become increasingly frustrated with congestion. However, the revenue generating potential of HOT lanes raises some important equity considerations in the provision of transport services. In situations where authorities have established minimum acceptable speeds or minimum levels of service on HOT lanes (which effectively places a cap on vehicle demand per hour), paying SOV's are likely to be seen as more desirable than non-paying rideshare participants. Indeed, the contract recently negotiated between Fluor-Transurban and the Virginia Department of Transportation (VDOT) to operate HOT lanes around the Capital Beltway in Washington, DC penalizes the Commonwealth when ridesharing is successful. The contract requires that VDOT pay Fluor-Transurban a penalty equal to 70% of the prevailing toll rate anytime HOV use exceeds 24% of vehicles on the facility in high demand periods (Virginia Dept. of Transportation, 2007). The specifics of the Fluor-Transurban contract does not require that the Commonwealth of Virginia stop promoting rideshare activities, but it certainly pushes the Commonwealth to reconsider how strongly they believe in ridesharing. Ideally, HOT lane schemes would allow rideshare vehicles (without the penalty) and paying SOV's, thereby segmenting the private vehicle commuting population into "those willing to wait", "those willing to pay" and "those willing to share".

### 5.4.2 Business Model / Revenue Model

A distinct challenge from the private rideshare service provider's perspective is how best to generate revenue from a rideshare arrangement. Generally, we have seen providers use four general approaches to revenue generation; offering matching services free of charge while relying on advertisement/marketing revenue, capturing a percentage of transaction value as it is transferred between passengers and drivers, the development of customized commuter information portals for employers/institutions, and the development of rideshare services for public agencies. Each of these revenue models have been used with varying levels of success, suggesting there is no single model that is ideal. However, research into rideshare participant behavior does suggest that some may be more suitable than others. Recent surveys from the US and the UK suggest that one of the largest motivators for both drivers and passengers to share rides is cost savings. If these surveys are reliable, this suggests that revenue models that attempt to charge either drivers or passengers are likely to discourage participation.

### 5.4.3 Service Competition within a Market

In many geographic areas, public and private sector providers compete against one and other (competition in the market). In the past, this has led to tension between the two stakeholder groups and ultimately to the creation of multiple, unconnected databases that provide little value to rideshare participants. However, competition between providers can be beneficial. For example, competition between firms offering competing ride-matching systems may yield a lower-cost system or one customized to local situations in a given market (competition for the market). With high initial development costs and the need for substantial participation ("critical mass") before sustainable levels of matched rides are reached, there is a strong argument for having a single ride-matching system in a given market. If competition within markets were encouraged, it is conceivable that multiple, non-connected ride-matching services would exist with no single service having sufficient participants to reach a critical mass. This feature of rideshare service delivery should be balanced against the previously described phenomenon of "Stranger Danger", in which rideshare participants are more likely to travel with people they know and trust. "Stranger Danger" suggests that numerous, small-scale ride-matching systems based on social networks may yield higher match rates. Ideally, services would compete for a particular market (a large organization, for example), but these individual services would be connected in such a way that participants could search for rides outside of their existing social network, and hence across provider platforms.

## 5.5 The Rideshare Challenge – Technological

The technological challenges associated with ridesharing have been the focus of many previous rideshare efforts, however the substantial advances that have been made have not translated into increases in participation. It is becoming increasingly clear that technological advances must be paired with solutions that address the previously described challenges if rideshare participation is expected to increase. This is not to say that there are no important technological challenges left to be addressed, indeed there are.

### 5.5.1 Measurement of Successful Rideshare Trips

If participants are to be rewarded for undertaking a rideshare trip, or if public agencies and employers are attempting to determine the effectiveness of their rideshare initiatives, there must be a method of measuring successful rideshare trips. Many current systems rely on the honor system to measure rideshare participation. When incentives are small, or when investment has been minimal, the lack of measurement and potential overstatement of successful trips may be an acceptable trade-off. However, when incentives are substantial and/or investment in rideshare initiatives is high, measurement becomes much more important as a way of measuring success and justifying the resources expended. If future rideshare initiatives are expected to see increased levels of discretionary investment and rely more heavily on incentive-based approaches, measurement of trips will be essential feature of ride matching services.

### 5.5.2 Establishing a Common Rideshare Data Specification

A large technological challenge to be addressed is the creation of a common data specification for storing and/or transmitting rideshare information. Addressing this technological challenge accomplishes very little in and of itself; however, it is a necessary preliminary step towards integrated, multi-modal travel information and the formation of rideshare trips from multiple databases.

Recent research conducted at the MIT has highlighted the multi-modal nature of commuting. In his thesis, Block-Schachter (2009) found that approximately 30% of MIT community members use multiple modes of transportation in a single week. The critical issue is one of choice; when commuters are given transport choices, they will alter their behavior day to day to meet their changing circumstances. As such, the integration of rideshare options with information on other modes of travel in a single commuting information source is an important step towards encouraging greater multi-modal behavior, including greater rideshare participation.

The development of a common data specification for ridesharing also enables the aggregation of multiple rideshare databases. Currently, many rideshare matching services seek to attract as many participants as possible to increase the probability of matching up a driver and passenger. However, most services can only search for matches within their own system. With a common data specification, multiple provider databases could be searched simultaneously potentially leading to higher overall number of matches and successful rideshare trips.

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# Chapter 6: "Real-Time" Ridesharing's Value Proposition

In Chapter 2, an innovative form of rideshare service known as "real-time" ridesharing, "dynamic" ridesharing or "technology-enabled" ridesharing was introduced. "Real-time" ridesharing has developed as a response to some of the inherent drawbacks of traditional rideshare arrangements. However, it is not without its own tradeoffs. This chapter will describe the features and technology underlying "real-time" ridesharing, potential methods of using such a service, some of the challenges that it addresses and some of the challenges that it exacerbates.

## 6.1 Description of "Real-Time" Ridesharing Features

Traditional ride matching systems, which were used starting in the 1970's, have changed dramatically over the years as technology has improved. Traditional ride boards, where one would write their availability or desire to ride on a card and wait for others to do the same, gave way to centralized databases. Participants would submit a ride request over the phone or by fax and several hours, days or weeks later they would receive a list of potential carpool participants whom they could contact if they so desired. These labor-intensive, central databases changed markedly with widespread access to the Internet. Web-based ride matching systems allowed users to set-up their own searches and receive a list of potential matches instantly. Throughout this period, "casual" ridesharing existed in a small number of locations, namely the SW suburbs of Washington, DC and the East Bay of the San Francisco, CA region. "Casual" ridesharing often involved passengers waiting at prescribed locations where they would be picked up by passing drivers. Neither participant committed to arrive at specified times. These arrangements were often undertaken to take advantage of HOV lanes, toll exemptions, and poor/expensive transit service.

Note that all of these previous systems, with the exception of the "casual" rideshare approach, were relatively passive in terms of matching up participants. The assumption was that rideshare arrangements would be long-term commitments and that participants would want to "research" potential candidates before contacting them. "Casual" ridesharing was unique in that it catered largely to those seeking one-time rideshare arrangements, but has a loyal following of participants that use the service on a daily basis (Oliphant, 2008). These participants simply arrive and are matched up with other commuters on a first-come-first-serve basis. Based on the variable nature of work and social schedules, the perceived need for occasional rideshare opportunities has increased, yet many of the traditional rideshare services are not well suited to accommodate this type of demand.

Referring back to the description of "real-time" ridesharing in Chapter 2, remember that it was defined as "a single, or recurring rideshare trip with no fixed schedule, organized on a one-time basis, with matching of participants occurring as little as a few minutes before departure or as far in advance as the evening before a trip is scheduled to take place". With this definition in mind, one can think of "real-time" ridesharing is an evolutionary step in service provision. The combination of smart phones with integrated GPS and an unlimited data plan has allowed service providers to match up participants in real-time, from virtually any location where cellular coverage exists. Many of the innovative rideshare services on the market offer "real-time" matching functionality while maintaining traditional ride matching options. When ride requests are submitted, a search for potential matches takes place in "real-time". If a suitable match is found, the participants are notified immediately. For those that seek single trips, there is no expectation that future rides will be undertaken with the same rideshare partner.

While the initial impression may be that "real-time" rideshare services are suitable only for single trips on short notice, this is not entirely accurate. The next section describes the different types rideshare trip that may be established using "real-time" ridesharing services.

## 6.2 Trip Types enabled by "Real-Time" Ridesharing Services

"Real-time" services are often marketed as allowing users to find single trips on very short notice, perhaps as little as 30 minutes ahead of time. However, is this type of rideshare offering perceived as valuable to potential participants? Research and focus groups conducted by researchers at the University of California – Berkeley found that of sixty focus group participants, less than a handful were interested in arranging "last minute" rides (Deakin, Frick & Shively, 2010). They felt that these "instant" trips would be difficult to arrange or simply would not work. Rather, participants were interested in arranging rides on a part time or occasional basis with notification of potential trips in advance, such as the evening before their commute to work. Deakin, Frick & Shively used the term "reliable flexibility" to describe this participant need. Based on this important insight, "real-time" ridesharing services could be used to enable three different types of trip; immediate trips, occasional trips and traditional, long-term rideshare trips.

Immediate trips might be undertaken when a passenger has found themselves with few transport alternatives. Perhaps they have missed a transit trip or their original rideshare opportunity fell through at the last minute. This type of arrangement has a larger “stranger danger” aspect than other types of ridesharing. In these cases, the need to identify a potential partner on short notice reduces the ability of both the driver and passenger to review each other’s profile. Further, because of the short notice, potential matches need to be contacted immediately and need to confirm that they intend to share a ride. Drivers may already be en-route when a request is made, and passengers are likely to be away from their home or office. For this type of trip, participants require ridesharing services that function on smart phones or other mobile devices so that they may make and confirm requests quickly. For this type of trip, the passengers receive a substantial benefit by being offered a rather customized travel option on short notice. For drivers, the motivation to offer this type of ride is unclear. The possibility of having to deviate from their existing trip on short notice, to pick up an individual that they probably do not know imposes a substantial burden with little apparent benefit. For this type of “real-time” rideshare trip to be successful, it is believed that drivers would need to be strongly incentivized. The ability to access HOV lanes or the use of financial incentives may appeal to drivers.

Occasional rideshare trips are likely to occur among commuters that would like to share rides, but have social schedules that change week to week, or work inconsistent hours. In these situations, participants would prefer to establish rideshare arrangements on a day-by-day, or ride-by-ride basis. For those with fixed travel times, it may be possible to specify rideshare opportunities once at the beginning of the week. For those with variable travel times, rideshare opportunities can only be posted on relatively short notice such as the evening before a morning commute, or around mid-day for an afternoon commute. Ideally, a “real-time” service would send a note to all participants that have identified themselves as looking for occasional rideshare trips at an established point, say 5pm weekday evenings. Participants would have several hours to confirm their desire to share a ride and their desired travel time. At a certain point, say 7pm, no further ride requests would be accepted for the following morning and matching would take place immediately. Several minutes after 7pm, participants that could not be matched would be notified and alternate travel options would be outlined. For those participants that could be matched, the personal details of the appropriate travel partner would be sent and both participants would have a short period of time to review the personal details of their partner and confirm their intention to ride with that individual. A similar process would take place around midday for the evening commute. In this arrangement, participants have some time to review their matched partner and accept or decline the rideshare opportunity, thereby limiting the “stranger danger” fears present in immediate rideshare arrangements. Since the posting and matching of these occasional trips occurs in a relatively short period of time (2-3 hours) and requires feedback from participants, rideshare services on smart phones are likely to be preferable, but computer-based systems could be used as well. Occasional trips provide benefits to both the driver and passenger. The advanced trip confirmation and passenger review allows the driver to plan ahead for a rideshare trip, and the scheduled nature of the matching means they only need to offer rides when it is convenient. If coupled with incentives, this may be quite a desirable arrangement for drivers. The reliability provided by the advanced trip confirmation and the benefit of a personalized trip are major advantages for the passenger. These occasional arrangements provide participants with greater schedule flexibility than traditional ridesharing while providing greater reliability than immediate rideshare opportunities.

Traditional rideshare arrangements, whereby drivers and passengers with similar and rather fixed schedules agree to share rides for a longer period of time, can also be provided by “real-time” rideshare services. In these instances, the importance of the personal characteristics of the driver and passenger are more important than the speed of matching. For longer-term arrangements, providers should encourage the completion of more detailed profiles by participants. Since matches are unlikely to be needed immediately, services on smart phones and traditional computers offer participants with multiple ways of reviewing potential partners and contacting them. While schedule flexibility is low in these situations, trip reliability is high. For traditional rideshare arrangements, a major challenge is keeping participants in the ride-matching database. If participants establish a consistent and long-term rideshare arrangement, there is no further need to log into a rideshare system. From a matching perspective, it may be reasonable to remove long-term rideshare participants from the database once they’ve found an appropriate match. However, if the goal of offering a rideshare service is more than simply providing ride matches (if it aims to measure rideshare participation or reward rideshare behavior, for example), than methods of encouraging participants to log their completed rides in the system are needed.

## 6.3 Opportunities and Challenges created by “Real-Time” Ridesharing

As the previous section on rideshare trip types has highlighted, there are a variety of opportunities and challenges created by “real-time” ridesharing. This section briefly highlights the benefits of “real-time” functionality in rideshare service provision.

### 6.3.1 Decreases Transaction Costs

Rideshare services, specifically those with smart phone functionality that actively contact participants with potential matches, can significantly reduce the amount of time needed to establish a rideshare arrangement. The automatic accessing of profile information remotely, including a participant's current location, minimizes the amount of direct user input needed. Decreasing these "transaction costs" (time needed to establish a rideshare trip) sometimes comes at the expense of a rigorous review of the profiles of potential rideshare partners. Some providers have attempted to overcome this perceived drawback by providing participant ratings that allow users to quickly determine how previous partners have perceived riding with a given person.

### 6.3.2 Improves Information Availability for Traveler Decision Making

Some "real-time" rideshare services integrate information from other modes of transportation in addition to rideshare options. In the event that a rideshare match cannot be established, transit and shuttle bus information can be provided to users allowing them to make more informed travel decisions.

### 6.3.3 Reduces "Stranger Danger" Concerns

While some features of "real-time" rideshare services may actually increase "stranger danger" concerns (such as the automatic matching of drivers and passengers), many services have incorporated features that reduce "stranger danger". Even for those services that use automatic matching, participants may still review the profiles of potential partners before accepting an offer when they are undertaking occasional or traditional rideshare trips. In addition, many services work on mobile devices with GPS that theoretically should be able to track each participant's position throughout a rideshare trip. If a participant agreed to share this type of information with a rideshare provider, it could be used to track participants and ensure that the agreed upon journey is taking place, and it could be used to validate that a successful shared ride was undertaken for those journeys where a financial transaction was agreed to, or where incentives are being disbursed. Many providers only target specific employers and require comprehensive registration processes, including registering with a corporate/institutional e-mail address, to verify the identity of participants, thereby providing an additional layer of safety.

### 6.3.4 Flexibility vs. Reliability Trade-Off

A large trade-off involved in the use of "real-time" ridesharing is the loss of trip reliability in exchange for trip flexibility. However, the degree to which these two features are traded-off depends on the type of rideshare trip being sought. While traditional rideshare opportunities suffer from a lack of flexibility, they are quite reliable. On the opposite end of the spectrum, immediate rideshare trips are very flexible, but provide little service reliability. Occasional trips, where matching takes place sufficiently far in advance of the start of the trip to allow for alternate travel arrangements to be made, tends to offer an acceptable balance between flexibility and reliability.

### 6.3.5 Valuable Travel Data vs. Loss of Privacy

“Real-time” rideshare services operating on smart phones with integrated GPS have the ability to generate much more valuable data than simple rideshare trip confirmation. If data were to be collected throughout the day, detailed travel patterns including the prevalence of trip chaining could be determined. From an urban planning and transport modeling perspective, this information could be used to supplement periodic travel diaries and improve the input data used in urban modeling endeavors. With a sufficiently large number of these devices collecting data, traffic patterns and congestion information could be generated. This information could be quite valuable to public agencies or rideshare providers themselves, however all of these examples of data collection involve a loss of personal privacy for the user of the phone. A fundamental challenge with future use of “real-time” rideshare services will be balancing the use of technology for innovative data gathering, while ensuring that personal data privacy is respected.

“Real-time” ridesharing begins to address a number of the economic and social challenges associated with traditional ridesharing. Additionally, it offers travelers with a wider variety of shared trip types in which to choose from, from immediate service, to occasional trips to longer-term, traditional rideshare arrangements. However, remember from the discussion of motivations in Chapter 3 that the main reasons for ridesharing include cost savings, travel time savings and environmental benefits. Many of “real-time” ridesharing’s service improvements do not directly address the core reasons that people choose to share rides. This author believes that while “real-time” services are a necessary and welcome innovation in rideshare provision, they do not on their own address enough of the major challenges inhibiting ridesharing to induce substantial shifts in mode choice. If “real-time” ridesharing is to be successful, it will need to be paired with other significant service improvements.

# Chapter 7: A Proposed Methodology for Estimating Rideshare Viability, applied to the MIT & VOLPE Transportation Center Communities

## 7.1 Introduction

As earlier sections of this thesis have highlighted, the potential benefits of ridesharing are numerous, and include opportunities to address some of the transportation sectors toughest challenges including congestion, energy security, GHG emissions and the provision of travel options. Yet, there exists very little in the literature on the realistic potential of ridesharing to address these problems. In fact, the literature detailing possible methodological approaches to estimate the market potential of ridesharing are even fewer. There are a number of potential reasons for this gap in the literature. Two of the most problematic barriers include the substantial amount of personal information needed to determine rideshare viability (detailed information from a large number of individuals on their daily travel habits) and the availability of resources to analyze the personal information (database software, transportation/GIS software). Because of these two barriers, attempts to understand the market potential of ridesharing can be excessively difficult. The prospects of a rideshare viability analysis at the scale of an organization are much better; the data requirements are not as onerous and often, neither are the analytical resource requirements.

A further reason for the lack of rideshare market analysis could be the importance of human preferences in the rideshare decision. Taking a quantitative, 'feasibility' approach to measuring market potential ignores the fact that choosing to rideshare is based heavily on human preferences and behavior. The value of a lengthy feasibility analysis may be diminished if one believes that human preferences are a much stronger determinant of rideshare participation than the physical characteristics of the trips undertaken.

This chapter outlines a data driven methodology for estimating rideshare potential at the scale of a large institution. Application of the methodology will be undertaken on a portion of the commuting population at the Massachusetts Institute of Technology using data from a bi-annual commuter survey, and on a portion of the population at the VOLPE transportation center using data from their inaugural commuter survey. The methodology will attempt to improve upon previous research by demonstrating, in the context of two large institutions, the realistic potential to rideshare based on trip characteristics (housing location, vehicle availability, arrival/departure time and route deviation time). While the analysis will focus on rideshare potential as determined by trip characteristics, it will benefit from commuter survey data showing observed travel choices. In effect, the modeled results suggesting who is likely to rideshare will be compared to observed behavior to determine the relative importance of trip characteristics and human preferences. By presenting strong results demonstrating the viability of ridesharing at MIT and VOLPE, this chapter aims to make the case for a targeted, technology-driven rideshare trial for the Kendall/MIT portion of Cambridge, MA.

## 7.2 Literature Review

As mentioned above, there is relatively little in the recent literature that has attempted to quantify the benefits of ridesharing, and even fewer sources have proposed a comprehensive methodology to do so. Given the rather large amounts of personal information required to determine market potential, it is conceivable that institutions or organizations have conducted these types of analyses but have kept the results private.

Research and consulting reports have been one source for quantifying rideshare market potential. One early attempt was a 1994 report summarizing the effectiveness of transportation control measures (TCMs) from various state-level trip reduction programs (Apogee Research, 1994). The report found that the provision of rideshare benefits at a regional level could eliminate up to 2% of VMT and 1% of trips. More recently, a report titled Moving Cooler estimated the GHG reduction potential from a wide range of transportation strategies, implemented individually and as bundles (Cambridge Systematics, 2009). For the strategy labeled “Employer-Based Commute Strategies” (of which ridesharing is a component), the COMMUTER mode choice model (Cambridge Systematics, 2009) was used to estimate mode shifts and the resulting change in emissions. The COMMUTER model uses aggregate mode choice data for different ‘classes’ of metropolitan area. Emission reductions from a specified baseline were estimated at 0.4 – 2.0% depending on the level of effort employed. The Growing Cooler results require some cautious interpretation; as one might expect, ‘employer-based commute strategies’ includes far more than ridesharing. In fact, this strategy includes provisions for ridesharing, a transit subsidy, modifications in parking policies, a compressed workweek provision and telecommuting. If ridesharing alone is isolated from this bundle, emission reductions from baseline are towards the lower end of the scale given previously (approximately 0.4%).

Academic research has also attempted to measure the potential market for ridesharing. A study by Tsao & Lin (1999) is one of the more comprehensive attempts to measure the potential of ridesharing based on spatial and temporal factors. Unfortunately, the study made several simplifying assumptions that greatly underestimate the potential of ridesharing, and likely led the authors to conclude that the benefits were too small to quantify. The study presented a hypothetical metropolitan area with a uniform density of jobs and workers across the entire area. This assumption, while simplifying the author's model specification, conflicts substantially with observed metropolitan spatial distribution of jobs and housing. In reality, metropolitan areas have substantially varied commercial and residential densities. Higher densities of either commercial or residential activity, and more specifically, the variability of densities across a geographic area is a major determinant of commuting patterns and increases the likelihood of finding a rideshare match. The authors also assumed that participants would only consider sharing a ride if they lived in the same two-mile by two-mile square area. While some recent research suggests that rideshare matching at the residential end of a trip is a strong determinant of rideshare potential (Buliung et al., 2010), Tsao and Lin's assumption effectively eliminates the ability to match riders and passengers based on the route they travel, thereby underestimating the number of potential riders. While the methodology was meant to look at rideshare potential in a hypothetical metropolitan area, it is important to note that both of the author's simplifying assumptions lead to an underestimation of rideshare potential.

An analysis conducted by students at the University of Toronto (Sarraino et al., 2008) attempted to measure the number of staff, faculty and students that could rideshare to the St. George campus (downtown Toronto), based on data provided by the university administration. The study used GIS software to identify common clusters of commuters that were traveling to campus. It was assumed that shared rides would only occur between drivers and passengers living within a 3 km radius of one and other. This residential proximity assumption is similar to the one used by Tsao and Lin, and could limit some mid-trip pairings. Commuters were only considered as matches if they were leaving their residence within the same 30-minute period. Unfortunately, due to data limitations, only AM residential departure times were available, making any assessment of return trip (or roundtrip) viability impossible. The analysis found that during morning commute hours (7:00 – 10:30am), 1,461 of 3,030 drive trips (48%) were suitable for ridesharing based on residential proximity and similar residential departure times. Had roundtrip matching been possible, the expected match rate would be lower.

The next sections will outline the analytical approach and results for MIT. A discussion of the VOLPE approach and results will follow, in a separate section.

## 7.3 Overview of MIT

MIT's main campus is located in Cambridge, MA directly across the Charles River from Boston, MA. The Institute is home to approximately 22,000 faculty, staff and students, of which approximately 18,000 are employed or study on the main campus in Cambridge (~8,000 faculty and staff, ~10,000 students) (MIT, 2009). MIT is well served by transit with access to the Massachusetts Bay Transportation Authority's (MBTA) Red Line at Kendall Square, two limited-stop bus services (the CT1 on Massachusetts Ave. & the CT2 on Vassar St.), and five regularly scheduled bus services (the #1, #64, #68, #70 & #85). Access to the MBTA commuter rail system is possible via the Red Line at South Station and at Porter Square Station, and via the MIT-supported E-ZRide bus shuttle with service to North Station (Block-Schachter, 2009). MIT owns approximately 4,000 parking spaces and leases an additional 500 spaces. (L. Brutti, personal communication, May 2, 2010).

The high level of transit service and MIT's location in relatively dense Cambridge, MA are two reasons that the use of transit and non-motorized transport are higher than in other parts of the Boston metropolitan area and much higher than the US average. Figure 7.1 summarizes mode choice for staff and faculty at MIT, Cambridge, MA, the Boston MSA and the US.

**Figure 7.1: Journey to Work Mode Share in 2008**

| Journey to Work Mode Share, 2008 | | | | |
|---|---|---|---|---|
| | MIT (Faculty & Staff Only) | Cambridge, MA | Boston MSA | US Average |
| Drove Alone | 28.2% | 29.9% | 69.1% | 75.5% |
| Rideshare | 8.2% | 4.6% | 8.2% | 10.7% |
| Transit | 35.7% | 27.2% | 11.7% | 5.0% |
| Bike, Ped & Other | 18.6% | 32.6% | 6.9% | 4.7% |
| Not on Campus | 9.3% | | | |
| Work from Home | | 5.7% | 4.1% | 4.1% |

Source: MIT, 2008 & US Census, 2008

The impetuses for further exploration of rideshare opportunities at MIT are numerous. First, parking on campus is becoming an expensive challenge for the Institute. The 500 leased parking spaces costs the Institute approximately $1.5M. a year in fees (L. Brutti, personal communication, May 2, 2010), and in recent years, the Institute has begun constructing underground, structured parking at an estimated cost of

$125,000 per space (Block-Schachter, 2009). Rideshare promotional efforts may be able to reduce the need for expensive parking construction and leasing. Second, the State of Massachusetts has begun a long-term project to rehabilitate a number of the bridges between Boston and Cambridge across the Charles River. Two of the bridges slated for closure and reconstruction, the Longfellow Bridge and the BU Bridge, are both in close proximity to MIT and will limit vehicle access to campus during the reconstruction phase. Ridesharing could be one important mitigation measure to ensure that an acceptable level of mobility is maintained in the southern part of Cambridge. Third, the Institute has made a commitment through the MIT Energy Initiative to 'Walk the Talk' and identify areas where energy consumption on campus can be reduced (MIT, 2007). Vehicle travel to and from campus is not an inconsequential portion of MIT's energy footprint; two separate student theses have estimated contributions of 4 to 14% of Institute-wide energy consumption coming from private vehicle travel (Block-Schachter, 2009, Groode, 2004). Ridesharing has the ability to provide additional transport options to the MIT community while helping the Institute 'Walk the Talk' on energy efficiency.

## 7.4 Analytical Approach for Rideshare Feasibility

A four step analytical approach was undertaken to estimate ridesharing potential at MIT: (1) MIT commuter survey preparation, (2) spatial analysis of commuter trips, (3) application of trip characteristic filters, and (4) selection of feasible pairings.

### 7.4.1 MIT Commuter Survey Preparation

MIT undertakes a comprehensive commuter survey every two years to measure commuter preferences and changes in commuting over time. The survey is administered to most of the MIT community and includes responses from undergraduates, graduate students, faculty, academic staff and support staff. The City of Cambridge and the Commonwealth of Massachusetts require that the survey be conducted. For this analysis, the 2008 version of the survey was used (MIT, 2008).

In 2008, MIT had approximately 21,800 community members including faculty, research staff, support staff, graduate students and undergraduate students. Of the full community, approximately 16,600 on-campus members were invited to complete the survey. Of the 5,200 that were not invited, over half were MIT staff working at the Lincoln Labs facility in Lexington, MA, approximately 15 miles from the main Cambridge campus. Approximately 10,300 community members completed the survey, representing a response rate of 62%. Completed survey responses were further filtered to isolate only community members that (a) commute to MIT's main campus for work/school, (b) live off-campus, (c) are either faculty or staff (students were eliminated from this analysis), and (d) had a residential address that could be properly geo-coded into a Latitude-Longitude value. Requirements (a) and (b) ensure that a commuting trip is taking place. Graduate and undergraduate students were eliminated from this analysis for several reasons. Undergraduates at MIT are required to live on-campus, or in Institute-sponsored, off-campus housing such as fraternities or sororities. These off-campus, undergraduate housing options are well served by the MIT-operated campus shuttle bus system. It was assumed that undergraduates will rarely, if ever, require a rideshare arrangement to travel to campus. Graduate students were eliminated because of the assumed variability of their daily schedules. The survey does ask for a community member's arrival time on campus and departure time from campus, but only "on a typical day". For graduate students, it was believed that responses to that question would be highly variable day to day and could undermine the value of the analysis. Further, graduate students have a much different pattern of residential selection than staff and faculty do. Students tend to live closer to campus, reducing their likelihood of choosing ridesharing as a mode of travel.

Two groups of commuters were identified for use in the feasibility analysis; all commuters regardless of their mode of travel (labeled "All Modes"), and those commuters that traveled to campus as a single occupant driver four or five times during the previous work week (labeled "SOV four or five times a week"). Note that the "SOV four or five times a week" group is a subset of the "All Modes" group. For the "All Modes" group, the variable of interest will be the percentage of commuters that can be successfully assigned a rideshare match. For the "SOV four or five times a week" subset group, the variables of interest will include the percentage of commuters that can be successfully matched, as well as the theoretical VMT savings that could be achieved from the elimination of one of the two daily SOV trips. Figure 7.2 shows the breakdown of the MIT community and the response rate to the survey.

**Figure 7.2: Makeup of the MIT Community and Responses to the 2008 Survey**

| Makeup of the MIT Community and Responses to the 2008 Commute Survey | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | Commuters Used in Market Analysis | |
| | MIT Population | Invited to Complete Survey | Completed Survey | Response Rate | Commuters - All Modes | Commuters - SOV 4 or 5 Times During Week |
| Total | ~21,800 | 16,578 | 10,273 | 62.0% | 5,061 | 1,247 |
| Faculty | ~1,020 | 933 | 467 | 50.1% | 461 | 130 |
| Staff | ~10,500 | 7,694 | 4,958 | 64.4% | 4,600 | 1,117 |
| Graduate Students | ~6,150 | 5,364 | 3,167 | 59.0% | N/A | N/A |
| Undergraduate Students | ~4,150 | 2,587 | 1,681 | 65.0% | N/A | N/A |

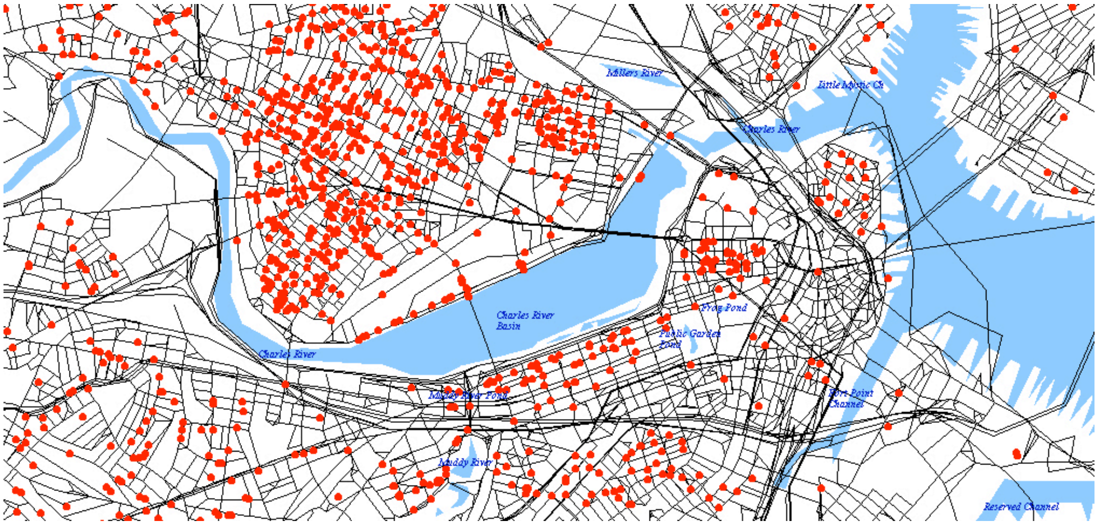
Source: Authors Analysis of MIT, 2008

### 7.4.2 Spatial Analysis of Commuter Trips

With 5,061 completed surveys by the targeted groups, including geo-coded residential locations, a spatial analysis of commuting trips to MIT was undertaken. A transportation network model of the greater Boston area developed in a previous academic course was used in conjunction with the TransCAD transportation modeling software package. The road network within the Boston model includes a value for congested travel time on every road link in the network, as calculated by an iterative assignment process during a previous 4-step transport-modeling endeavor. Whereas the University of Toronto approach looked for clusters of commuters at the residential end using a GIS-buffer approach, this approach capitalizes on the availability of a congested road network that allows for the use of a least-cost travel time algorithm to assign commuters to a path they would theoretically choose to get to MIT. In clearer terms, while the University of Toronto approach made matches based on residential proximity only, the proposed approach makes matches based on the route that commuters are most likely to choose. The added benefit of this approach is that it allows for the matching of drivers and passengers mid-trip, along the driver's path. One possible shortcoming of the network used in this analysis was the lack of realistic capacity constraints at the nodes, or the lack of real-world traffic signal timing, in other words. The timing for only two-dozen traffic signals around the MIT campus were coded into the network, suggesting that modeled travel times may be faster than what one would typically experience in Boston.

The 5,061 geo-coded commuter records were imported into TransCAD as a series of points. One additional point representing the main entrance to the MIT campus at 77 Massachusetts Avenue was added to the list. The commuter points were linked to the nearest intersection on the road network using a spatial join. A network skim of travel time and travel distance was performed from all spatially joined intersections to all other spatially joined intersections. The values were exported to a database where the skimmed intersections were expanded back to individual commuter records. Since this procedure was essentially taking the travel time and distance between all 5,062 records, it generated a database table with 25.6M commuter pairings (5,062 x 5,062), many of which have real potential for ridesharing and some of which are not at all feasible. The third step, applying trip characteristic filters, is where only those rideshare pairings that are feasible are identified. Figure 7.3 shows an example of the residential locations of commuters in the immediate vicinity of MIT. Large points represent the geo-coded residential locations of MIT staff and faculty near the MIT Campus.

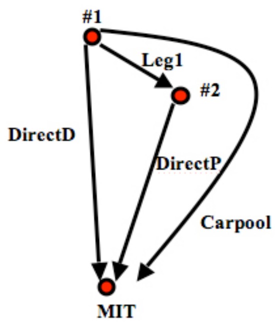
**Figure 7.3: TransCAD Visualization of the Commuter Survey Records**




### 7.4.3 Application of Trip Characteristic Filters

The third step involved filtering the millions of commuter pairings generated in TransCAD down to only those that could be reasonably expected to share rides. With the table of 25.6M. records, one must first determine the direct distance and travel time to MIT for all 5,061 commuters. Since MIT's location was coded as one of the records, this was simply a process of extracting a subset of the existing data table (those pairings where the MIT node was the destination). One can think of these as the SOV distances and travel times for both a driver and passenger in a potential rideshare arrangement, if they both chose to drive to campus. In the rideshare diagram shown in Figure 7.4, these are the segments labeled 'DirectD' and 'DirectP' for commuters #1 and #2 respectively. The next step involved calculating the carpool distance and travel time. Carpool values were assumed to be the distance/time from the 'driver's' residence to the 'passenger's' residence (the segment labeled 'Leg1'), plus the distance/time from the 'passenger's' residence to MIT (the segment 'DirectP'). At this step in the analysis, no restrictions were placed on rideshare roles, so commuters could be identified as drivers or passengers. The difference in values between the 'driver's' direct trip to MIT ('DirectD') and the carpool distance/time ('Leg1' plus 'DirectP') is a particularly important trip characteristic filter that will be described later in this section.

**Figure 7.4: Conceptual Rideshare Diagram**




At this point, several important assumptions have been made that should be stated explicitly. First, this approach assumes that only two-person carpools are possible. This assumption was made to simplify the matching process, however it is not believed to significantly affect the results. The complexity of identifying a third or fourth rideshare participant with a similar schedule and the additional travel time burden of picking up another passenger is likely to limit the number of feasible rideshares with three or more people. Second, the approach assumes that a driver is willing to deviate from their normal route to MIT to pickup a passenger at their residential location. The prospect of drivers and passengers meeting at a mutually beneficial intermediate destination was not considered. Once again, this assumption was made to simplify the matching process. Third, it was assumed that when a driver deviates to pickup a passenger, the pickup time is zero. This assumption is certainly optimistic and understates the commitment the driver is being asked to make. Even in instances where the passenger is prompt, there is likely some perceived, or psychological wait time experienced by the driver, however this is partially compensated for by placing a rather strict limit on the length of deviation that the driver is willing to incur to pick up a passenger. Fourth, the chaining of trips to and from campus were ignored. No information on trip chaining behavior was available in the survey.

A series of filters were applied to isolate only those commuter pairings that were believed to be feasible for ridesharing. The following list outlines the filters used and the rationale for applying them.

(a) The 'driver' is only willing to accept a deviation of five minutes (5 minutes) or less from their normal drive-alone travel time. This was the difference between the 'DirectD' segment travel time and the calculated carpool travel time outlined previously. A five-minute threshold was chosen based on previous rideshare survey findings. Li et al. (2007) found that 75% of 2-person carpools in Texas involved a deviation of five minutes or less. Attanucci (1974) previously found that 51% of members of the MIT community were willing to deviate no more than five minutes and an additional 29% were willing to deviate between five and ten minutes. Note that this filter does not restrict the direction of travel. If a passenger is two minutes in the opposite direction from the driver's residence (and thereby ads a total of four minutes to the entire journey), the filter suggests that that trip is as likely to occur as one that requires a four minute deviation perpendicular to the driver's residence. While this is assumed not to be a substantial burden, it may very well be for a subset of drivers. Sensitivity analyses are also performed at 2 minute and 10 minute deviation thresholds.

(b) The 'driver' is unwilling to spend more than 150% of his drive-alone travel time to rideshare to campus. This filter only affects those that are already relatively close to MIT. For example, if a driver normally has an eight-minute commute to campus, this filter will limit the feasible set of passengers to those that add four-minutes or less to the driver's journey. For commutes longer than 10 minutes, the "five-minute deviation threshold" filter described above replaces this filter. As such, this filter eliminates relatively few pairings, but pairings that are quite unlikely to represent desirable rideshare arrangements.

(c) 'Passengers' within 1 mile of campus are excluded from consideration. Within a distance of 1 mile, the attractiveness of walking, cycling and transit should be much higher than the attractiveness of ridesharing.

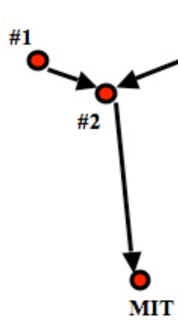
(d) The 'driver' in the rideshare arrangement must have access to a vehicle. The 2008 MIT Commuter survey asks respondents whether they have access to a private vehicle for daily commuting.

(e) The 'driver' and 'passenger' in a rideshare arrangement must arrive on campus and depart from campus within the same 30-minute period. The 2008 survey asks participants to provide their arrival/departure time to/from campus on a typical day. Respondents are provided with 30-minute blocks of time (7:00-7:29am, 5:30-5:59pm, etc.) and are asked to choose only one block. The implication of having both arrival and departure times matching for both the 'driver' and 'passenger' is that roundtrip carpool opportunities are assumed.

### 7.4.4 Selection of Feasible Pairings

At this point, those commuter pairings that are believed to be feasible have been identified. However, there are often cases where a driver has the option of picking up multiple passengers, or passengers can be matched up with multiple drivers, such as the case shown in Figure 7.5. In this figure, two driver-passenger pairings are possible, but on any given day, only one of those pairings is possible. Adding to the complexity, there is nothing stopping a commuter from being a driver in one pairing and a passenger in another pairing. Since the assumption is that only two people can share a ride at any given time, this step requires the specification of a decision variable to select 'feasible' pairings such that no commuter (driver or passenger) is paired up more than once on any given day. In more general terms, one can think of the output of Step 3 as the full list of feasible pairings that are possible, whereas the purpose of Step 4 is to select only those pairings that are possible on any single day. This final step is seeking to maximize the number of members of the MIT community that can be matched by employing an optimization process.

**Figure 7.5: Rideshare Pairings (Two Pairings Possible, Only One Pairing on a Single Day)**

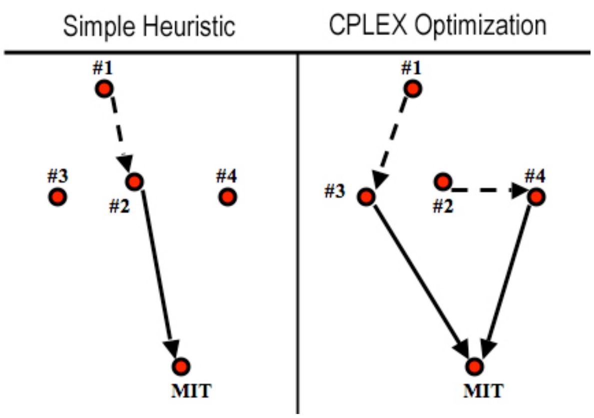



Two approaches were considered to identify 'feasible' pairings; one option used the CPLEX algorithm in the OPL Studio software suite, and the second option involved a simple heuristic approach using a standard spreadsheet program. The CPLEX approach involved solving a general network flow problem with side constraints to ensure that a commuter was not paired up as both a driver and a passenger in separate pairings. For the "All Modes" subset of commuters, the objective function used was the maximization of commuter pairs. For the "SOV four or five times a week" subset, the objective function used included the maximization of commuter pairs and the maximization of VMT savings.

The heuristic approach began by sorting the list of pairings from highest to lowest by potential VMT savings, and then employed an iterative approach of selecting drivers and passengers. The first driver-passenger pair with the largest VMT savings was "activated", and both commuters were removed from consideration in all further pairings. Moving onto the next pairing, both the driver and passenger were checked to see if they were "available" for matching. If either the driver or passenger were previously "activated", the selected pairing was discarded and the next pair was considered. This process is repeated for all pairings in the list. The decision variable for both subsets of commuters ("All Modes" and "SOV four or five times a week") is the maximization of commuter pairs, but implicitly VMT savings are also considered given the initial sorting that took place.

The two approaches have different strengths and weaknesses. The CPLEX optimization approach provides an outcome that is more robust, but requires writing the problem statement in the proprietary language of the software, which is relatively time consuming. The heuristic approach is quite simple to implement in commonly available spreadsheet programs, is not particularly time consuming, but provides a sub-optimal set of feasible pairings. As demonstrated in Figure 7.6, the heuristic approach may select a single driver-passenger pair that has relatively high VMT savings, whereas the CPLEX approach may identify two pairings, each with relatively smaller VMT savings, but where the total savings from the combined pairings are larger than the single, high VMT pairing. For this analysis, both the CPLEX and heuristic results will be reported.

**Figure 7.6: Difference in Optimal Pairing Selection, Simple Heuristic vs. CPLEX Optimization**




**Commuters #3 and #4 remain unpaired using the 'simple heuristic' approach

## 7.5 Results and Discussion

### 7.5.1 Ridesharing Viability at MIT with Sensitivity Analyses

Figures 7.7, 7.8 & 7.9 summarize the results from the analysis of rideshare potential among members of the MIT community. Figure 7.7 shows the results of the 'base case' analysis (five-minute route deviation threshold) and Figures 7.8 & 7.9 show the results of the two sensitivity analyses (two-minute and ten-minute deviation thresholds). Each figure has the results for the "All Modes" subset of commuters on the left and the "SOV four or five times a week" subset on the right. The number of feasible pairings and the number of pairings possible on a single day are reported, along with the associated percentages of the total commuter population evaluated. For the "SOV four or five times a week" subset, the daily VMT savings achievable from ridesharing are also provided.

**Figure 7.7 Summary of Rideshare Potential at MIT, Base Case**

| Base Case: Five-Minute Route Deviation | | | | |
|---|---|---|---|---|
| | Commuters - All Modes | | Commuters - SOV 4 or 5 Times During Week | |
| | CPLEX Optimiz. | Heuristic | CPLEX Optimiz. | Heuristic |
| All Commuters | 5,061 | | 1,247 | |
| Commuters - Ridesharing is Feasible | 4,228 (83.5%) | | 977 (78.3%) | |
| Commuters - Ridesharing Feasible on a Single Day | 3,670 (72.5%) | 2,942 (58.1%) | 832 (66.8%) | 800 (64.2%) |
| Avg. Daily SOV Commute VMT (All SOV Commuters) | | | 17,104 | |
| Daily VMT Reduction | | | 3,279 (19.2%) | 3,218 (18.8%) |

**Figure 7.8: Summary of Rideshare Potential at MIT, 2-Min Sensitivity**

| Sensitivity Analysis: Two-Minute Route Deviation | | | | |
|---|---|---|---|---|
| | Commuters - All Modes | | Commuters - SOV 4 or 5 Times During Week | |
| | CPLEX Optimiz. | Heuristic | CPLEX Optimiz. | Heuristic |
| All Commuters | 5,061 | | 1,247 | |
| Commuters - Ridesharing is Feasible | 3,529 (69.7%) | | 608 (48.8%) | |
| Commuters - Ridesharing Feasible on a Single Day | 2,920 (57.7%) | 2,536 (50.1%) | 440 (35.3%) | 432 (34.6%) |
| Avg. Daily SOV Commute VMT (All SOV Commuters) | | | 17,104 | |
| Daily VMT Reduction | | | 1,487 (8.7%) | 1,468 (8.6%) |

**Figure 7.9: Summary of Rideshare Potential at MIT, 10-Min Sensitivity**

| Sensitivity Analysis: Ten-Minute Route Deviation | | | | |
|---|---|---|---|---|
| | Commuters - All Modes | | Commuters - SOV 4 or 5 Times During Week | |
| | CPLEX Optimiz. | Heuristic | CPLEX Optimiz. | Heuristic |
| All Commuters | 5,061 | | 1,247 | |
| Commuters - Ridesharing is Feasible | 4,452 (88.0%) | | 1,151 (92.3%) | |
| Commuters - Ridesharing Feasible on a Single Day | 3,904 (77.1%) | N/A | 1,080 (86.6%) | 1,034 (82.9%) |
| Avg. Daily SOV Commute VMT (All SOV Commuters) | | | 17,104 | |
| Daily VMT Reduction | | | 4,640 (27.1%) | 4,518 (26.4%) |

There are a number of important insights that follow from this analysis. To begin, the percentage of the MIT community that can feasibly share rides is very high. Depending on the driver deviation assumptions, between 70% and 88% of the surveyed MIT community has the option of engaging in ridesharing. For those whose primary mode of commuting is SOV travel, approximately 49% to 92% could rideshare if they chose to do so, again depending on the driver deviation assumptions.

On a daily basis, approximately 50% to 77% of the MIT Community could rideshare depending on the model assumptions. This is an order of magnitude higher than the current share of the community that chooses to rideshare (8.2%). In terms of VMT reduction potential, the model suggests that 9% to 27% of daily, commuter-based VMT could be reduced through choosing to rideshare, with a base-case estimate of a 19% daily reduction in VMT. If one now considers the 0.4% (Cambridge Systematics, 2009) and 2% (Apogee Research, 1994) metro-wide, VMT reductions quoted in previous reports, it becomes clear that ridesharing's potential differs markedly depending on the physical/institutional scale considered (metropolitan area vs. an organization).

Finally, from a methodological standpoint, it is interesting to consider the difference between the CPLEX optimization and simple heuristic approaches to identifying the feasible rideshare pairs on a single day. In terms of the maximization of pairings, one can clearly see that larger datasets favor the optimization approach. For smaller datasets, the difference between the two approaches is less pronounced. For the determination of VMT savings, the two approaches yield remarkably similar results.

### 7.5.2 Modeled Potential vs. Observed Behavior

While the aggregate results of rideshare potential at MIT are interesting, the comparison of the modeled results against the observed travel behavior of the MIT community is also worth examining. The matrix shown in Figure 7.10 compares the modeled and observed travel behavior for the 5,061 commuters considered in the 'base case' analysis. Along the left side, community members are identified by their modeled rideshare feasibility. Along the top, they are identified by whether they engaged in any form or ridesharing (carpool or vanpool) at least once during the previous workweek. The "All Modes" group of commuters was used rather than the "SOV four or five times a week" subset because the analysis is attempting to compare modeled *rideshare* behavior to observed commuter *rideshare* behavior, regardless of whether or not these commuters are the ones that would be targeted for an MIT community-based rideshare initiative. If the analysis was limited to the "SOV four or five times a week" subset, it would be attempting to compare modeled and observed *rideshare* behavior for a subset that was selected specifically because they do not currently rideshare, largely defeating the purpose of the analysis. However, it would be false to state that 3,615 commuters should be targeted in a rideshare initiative. This group includes community members that already use sustainable modes of travel to get to MIT; they walk, cycle or take transit. From a policy standpoint, the 946 frequent SOV drivers should be the primary target for rideshare participation. As was explained in the Introduction, this exercise was not meant to consider human preferences so the fact that the majority of the results are not in these two quadrants should not be surprising.

**Figure 7.10 Modeled Rideshare Potential vs. Observed Commuting Behavior**

| Comparison of Modeled Rideshare Potential vs. Observed Commute Behavior ("All Modes") | | | |
|---|---|---|---|
| | | **Observed Commute Behavior** | |
| | | Shared a Ride during the Previous Week | Did not Share a Ride During Previous Week |
| **Modelled Results** | Ridesharing Not Feasible | **201** | **632** |
| | Ridesharing Feasible | **613** | **3,615** |
| | | | **946 'SOV 4 or 5 Days/Wk'** |

Source: Author Analysis of MIT, 2008

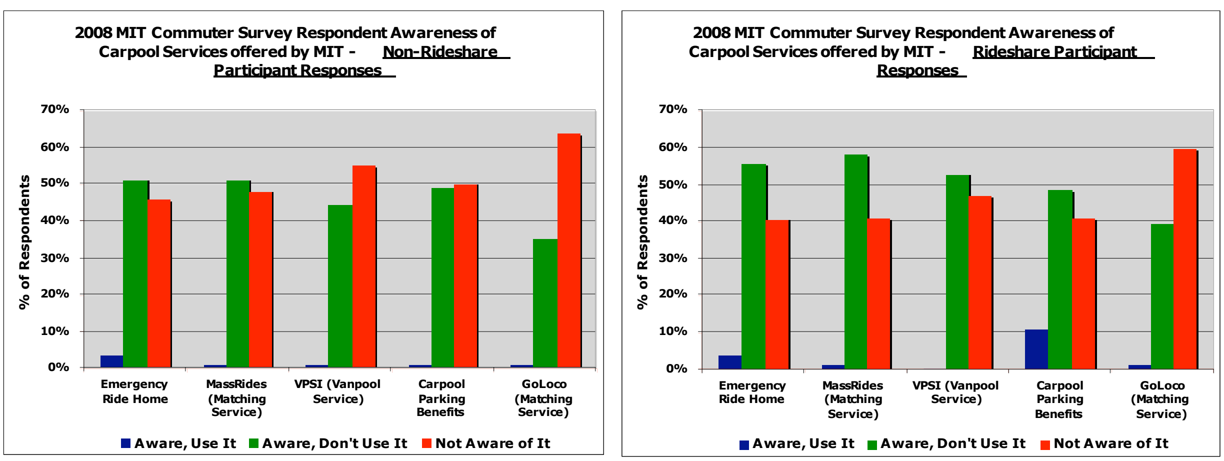
The presentation of the results in this format clearly identifies the group of commuters that should be targeted for an MIT rideshare initiative. The 946 frequent SOV commuters who could potentially rideshare but have not done so in the previous week are clearly the primary group for further rideshare promotional efforts.

At first glance, the 201 community members that shared a ride when the model suggests they should not have (top-left quadrant) is concerning as it suggests deficiencies or missing variables in the model. Two possible explanations for this include (a) filters that were too restrictive, and/or (b) the influence of unobserved human preferences, particularly the incidence of ridesharing with family members not affiliated with MIT. It is possible that the filters applied were too restrictive in identifying those commuters most likely to rideshare. Based on previous research suggesting that 25% to 80% of ridesharing trips are intra-household (Attanucci, 1974, Kendall, 1975, Pisarski, 2006, Li et al., 2007, Morency, 2007), or between family members, it seems likely that some of these shared rides are family based, where at least one participant is not affiliated with MIT. Unfortunately, the MIT Commuter Survey does not ask respondents to indicate with whom they shared a ride.

### 7.5.3 Why do Commuters that Could Rideshare Choose Not to?

Naturally, for the subset of commuters that could rideshare but are choosing not to (the subset of 3,615 in Figure 7.10), the obvious question that comes up is "why not"? Why do commuters that could rideshare according to our model choose not to? As has been suggested elsewhere, human preferences are believed to be a major factor. The variability of schedules, trip-chaining, the lack of convenience in having to pick up a passenger or rely on another driver, and the flexibility of being able to change ones travel plans on short notice are common arguments against ridesharing. Unfortunately, the 2008 MIT Survey did not ask respondents any questions about whether they would consider ridesharing. The survey did however ask respondents about their familiarity with various carpool services and benefits offered by the Institute. Respondents were asked to acknowledge whether they were aware of and used a service, were aware of but did not use a service or were unaware of a particular service. The services/benefits provided include emergency ride home, two ride-matching services (MassRides and GoLoco), the VPSI vanpool service and carpool parking benefits. Figure 7.11 presents the level of awareness of MIT rideshare benefits by *non-rideshare* community members. Figure 7.12 presents the level of awareness by *ridesharing* community members.

**Figures 7.11 & 7.12: Respondent Awareness of Rideshare Services and Benefits Offered by MIT**




Source: Authors Analysis of MIT, 2008

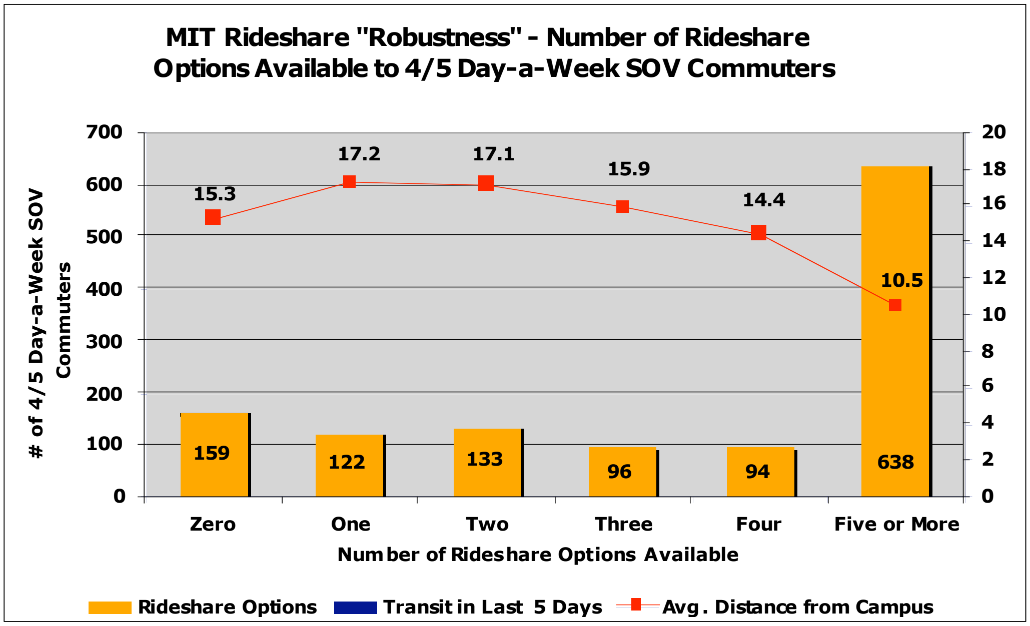
One important finding from the answers to these questions is the lack of awareness among the MIT community about the carpool services and benefits available. In all cases, over 40% of respondents were not aware that a particular service was available to them. One must be careful in how this statistic is interpreted; after all simply knowing that a particular benefit exists does not mean that it will be used. In fact, it's quite possible that for some portion of the commuting population, the provision of benefits will make no difference in their consideration of whether or not to rideshare. In the 2006 MIT Commuter Survey, respondents were asked under what conditions they were likely to rideshare more often (more parking benefits on non-carpool days, improved travel options for the trip home, etc.). Over a sixth of the respondents stated that they would never consider sharing a ride (MIT, 2006). While the 2008 results do not conclusively explain why respondents choose to rideshare or not, they do indicate that some potential mode shift may be possible simply by providing improved information about the services that the Institute offers.

### 7.5.4 Rideshare Robustness – The Probability of Finding a Ride Home

A common reason for avoiding ridesharing has been a concern over the reliability of the return trip. With the development of new "real-time" rideshare service models, where drivers and passengers pair up for one-time trips (often on short notice), this concern is particularly relevant. A benefit of the methodology applied earlier in this chapter is that it generates a list of all possible driver pairings for each passenger. With this information, it is possible to determine the "robustness" of the rideshare arrangements at MIT. In other words, it provides an answer to the question of how many alternate rideshare opportunities a passenger has available in the event their original driver cannot offer them a ride home.

For this analysis, the results in Figure 7.7 are a useful starting point. In the initial setup of the analysis, 1,247 community members that drove alone four or five days a week were identified. If ridesharing efforts were marketed largely at this group of individuals, the question to be answered is how many of those participants have more than one travel option to get to and from MIT? One additional constraint was placed on the analysis; rather than departing from campus during their "typical" 30-minute window, it was assumed that passengers would be willing to depart up to one 30-minute window later than normal. In other words, if passengers typically departed between 5:00-5:29pm, it was assumed that they would be willing to depart between 5:00-5:59pm if it meant that they would be able to share a ride home. It was assumed that drivers would not be willing to modify their behavior to accommodate a passenger and would still depart during their "typical" 30-minute window. The results of the analysis are presented in Figure 7.13 below.

**Figure 7.13: MIT Rideshare "Robustness" for a Subset of the Commuting Population**




Source: Authors Analysis of MIT, 2008

Figure 7.13 shows the number of community members with zero rideshare options, one option, two options, three options, four options and five or more rideshare options. For those with zero or one option, the survey was analyzed to determine whether the passenger had used any other modes of transportation in the previous week, as this would suggest that they have other, non-private vehicle modes that can be relied upon. The plotted line corresponds to the average distance from campus for all commuters in each option category. The analysis suggests that 281 of the 1,247 participants (23%) have no rideshare options, or would be entirely reliant on their original rideshare partner. Although the results for those passengers with 5+ rideshare options looks surprisingly high, it is worth stressing that many live within one to three miles of campus and are likely very near to major commuting corridors such as Massachusetts Avenue or Beacon/Hampshire Street where mid-trip pairings are feasible. Overall, the robustness results are both positive and negative. While the variety of travel options for this subset of passengers appears to be relatively high, it is those passengers that live the furthest from campus (and are most likely to engage in ridesharing) that have the fewest alternate travel options for their return trip. This clearly highlights the importance of 'Guaranteed Ride Home' benefits for rideshare participants.

The robustness analysis should be qualified. First, it was assumed that all 1,247 participants would be willing to share rides on a given day. In the event that a number of the drivers or passengers decided to use some other mode of travel on that particular day, the robustness of the system would decrease. On the other hand, if drivers that commuted to campus one, two or three days a week were included in the analysis the robustness would be expected to increase somewhat.

## 7.6 Methodology Application to the VOLPE Transportation Center

The VOLPE Transportation Center is located in the Kendall Square area of Cambridge, MA, adjacent to the MIT campus. VOLPE provides research, development and analysis services for a variety of public and private sector clients, with expertise in all modes of transportation and transportation logistics. The Center is made up of a mix of public sector employees and on-site, private contractors. In December 2009, VOLPE conducted their first Federal Employee Commuter Survey (US DOT, 2009) as part of a larger effort to improve environmental performance of the Center. A total of 405 federal employees (66% response rate) completed the survey (US DOT, 2009). On-site, private contractors were not a part of the survey. Using a nearly identical methodology to the one described earlier in this chapter, the market potential for increased ridesharing at VOLPE was explored.

An analysis of VOLPE's commuter survey was an important compliment to the MIT analysis. As stated earlier, it is not clear that the rideshare potential at MIT is similar to the rideshare potential of other MIT/Kendall Square area institutions, due in part to MIT's relative size. The VOLPE Center is located in the same general vicinity as MIT and has similar transport access characteristics, but is smaller than the Institute making it an ideal organization to analyze. Further, VOLPE used the structure of the MIT Commuter Survey when designing their survey, so the structure of the questions and responses are very similar and allow for relatively easy comparisons. For these reasons, an analysis of rideshare feasibility at VOLPE was a natural extension of the MIT analysis.

### 7.6.1 Differences in the Methodology

A very similar methodology to the one applied to the MIT Commuter Survey was applied to the VOLPE survey. As compared to the MIT survey, there were four major differences in how the approach was applied:

(1) The VOLPE survey only asked participants to provide the zip code of their residential location rather than the names of the nearest intersecting streets. This limitation meant that residential locations could not be geo-coded. Instead, each residential location was randomly assigned within the commuter's zip code, and then linked to the nearest intersection in the TransCAD network file.

(2) The VOLPE survey asked employees to provide their arrival time at the Center in 60-minute blocks of time (7:00-7:59am, etc.). In contrast, the MIT survey asked the same question, but provided 30-minute blocks of time. These wider blocks are problematic in that they lead to an overstatement of rideshare potential. Commuters that typically arrive at 7:05am are not likely to be willing to share rides with employees that typically arrive at 7:55am, but the methodology applied would consider them as appropriate matches.
(3) The VOLPE survey only asked employees when they arrived at the Center, not when they departed at the end of the day. For this analysis, it was assumed that all employees were onsite for 8.5 hours.
(4) Only the heuristic approach was used to identify feasible pairings. No sensitivity analyses were run on the results; it was assumed that drivers would be willing to deviate a maximum of 5 minutes to pick up a passenger.

Beyond the four differences described above, the approach was largely the same as the one applied to MIT. The 405 initial survey responses were filtered down to two target groups of commuters; commuters using multiple modes, and those that commute four or five days a week. The initial filtering process ensured that the target groups were full time employees, that VOLPE was their primary work location, and that each employee provided a valid home location identifier (in this case, a valid zip code), and a recorded arrival time to work. This process identified 346 complete “All Modes” records and 113 “SOV four or five times a week” records. Remember that the “SOV four or five times a week” records are a subset of the “All Modes” records.

A spatial analysis in TransCAD was undertaken to calculate congested travel times and travel distances for each employee. In VOLPE’s case, the fact that residential locations were identified using zip codes meant that a slightly different approach was required. A new zip-code layer was added to TransCAD and the survey counts were randomly assigned within each zip code area. They were than linked to the nearest roadway intersection and the congested travel times and travel distances were calculated as described in the MIT analysis.

The next step was identifying all potential ride matches. The assumptions were identical to those used in the MIT analysis, with the exception of the arrival time and departure time assumptions, as mentioned earlier in this subsection. While the arrival time windows were larger than those in the MIT Commuter Survey, the technical approach was identical.

Finally, the identification of feasible rideshare trips on any given day were calculated using the heuristic approach, described earlier in the chapter. No sensitivity analyses were undertaken, the only case presented assumes that drivers are willing to deviate no more than 5 minutes to pick up a passenger. Figure 7.14 below presents the results from the analysis.

**Figure 7.14: Summary of Rideshare Potential at the VOLPE Transportation Center**

| VOLPE Transportation Center Analysis: Five-Minute Route Deviation | | |
|---|---|---|
| | Commuters - All Modes | Commuters - SOV 4 or 5 Times During Week |
| All Commuters | 346 | 113 |
| Commuters - Ridesharing is Feasible | 264 (76.3%) | 81 (71.1%) |
| Commuters - Ridesharing Feasible on a Single Day | 238 (68.8%) | 70 (61.9%) |
| Avg. Daily SOV Commute VMT (All SOV Commuters) | | 4,294 |
| Daily VMT Reduction | | 243 (5.7%) |

Source: Authors Analysis of US Dept. of Transportation, 2009

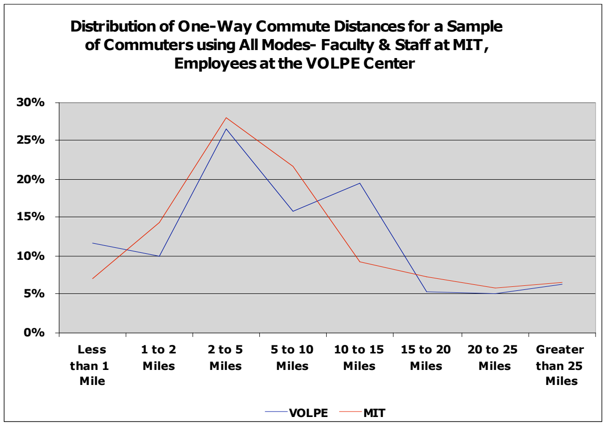
### 7.6.2 Discussion of the Results

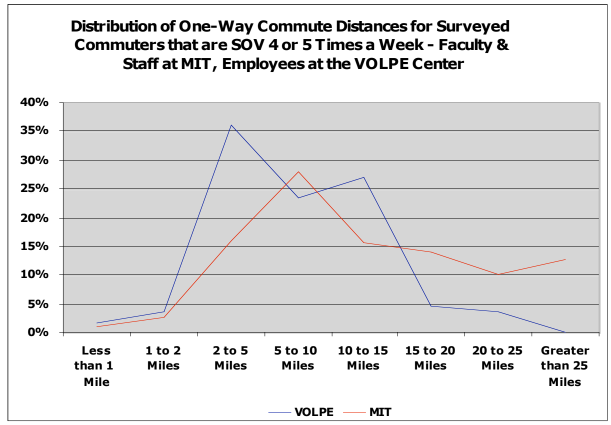
The results presented in Figure 7.14 provide evidence that there is potential for increased ridesharing at VOLPE. The analysis suggests that 76% of commuters at the VOLPE Center could feasibly rideshare. For commuters that currently drive alone four or five days a week, 71% could feasibly share rides. This compares to 84% of commuters and 78% of drive-alone commuters in the MIT analysis.
On a daily basis, 69% of all VOLPE commuters and 62% of 4/5 day-a-week SOV commuters could rideshare. This compares favorably to the 72% of all commuters and 64% of 4/5 day-a-week SOV commuters that could rideshare at MIT.

Given the substantial difference in the sizes of these two institutional communities, the similarity of the results is surprising. Intuition would suggest that MIT, with over ten times the number of consistent SOV commuters, would have substantially higher match rates. At least part of the similarity in the results could be due to the much larger arrival time windows in the VOLPE survey and the across-the-board assumption that all employees spend 8.5 hours at the Center. All else being equal, these aspects of the analysis would lead to higher match rates.

With relatively similar match rates, it is interesting to note how much lower the VMT reduction potential is at VOLPE than at MIT. On an ideal day, VMT reductions at VOLPE would amount to 6% while at MIT they would be closer to 19%, for 4/5 day-a-week SOV commuters. This finding implies that the average MIT SOV commuter is driving substantially further to get to MIT than the average VOLPE SOV commuter is to get to VOLPE. It may also suggest that passengers in MIT rideshare opportunities are being picked up much closer to the driver's house, rather than partway along the route. Figures 7.15 and 7.16 present the distributions of commuting distance for all commuters, and for 4/5 day-a-week SOV commuters at both MIT and VOLPE. Note that the distribution of travel distance is nearly unchanged for all VOLPE commuters vs. frequent VOLPE SOV commuters. In other words, frequent drivers are traveling approximately the same distance as commuters using other modes. For MIT, the difference between the distributions is rather substantial. On average, frequent SOV commuters travel further to get to campus than those relying on other modes. Note that VOLPE has higher percentages of frequent SOV employees driving shorter distances (2-15 miles), while MIT has higher percentages of frequent SOV employees traveling longer distances (15 miles or more). There are several potential reasons for the differences in the commuting distance distributions for the two institutions, one of which is the difference in the costs of parking. While MIT charges a highly subsidized rate for parking (~30% of market rate)(Block-Schachter, 2009), VOLPE employees receive parking free of charge (US DOT, 2010). Free parking would typically encourage commuters living closer to their workplace to drive more frequently, rather than rely on alternate modes of transportation. This would likely explain at least some of the greater incidence of short distance SOV commuters at VOLPE.

**Figures 7.15 & 7.16: Distributions of One-Way Commuting Distances for All Commuters, and for Four or Five Day-a-Week SOV Commuters**



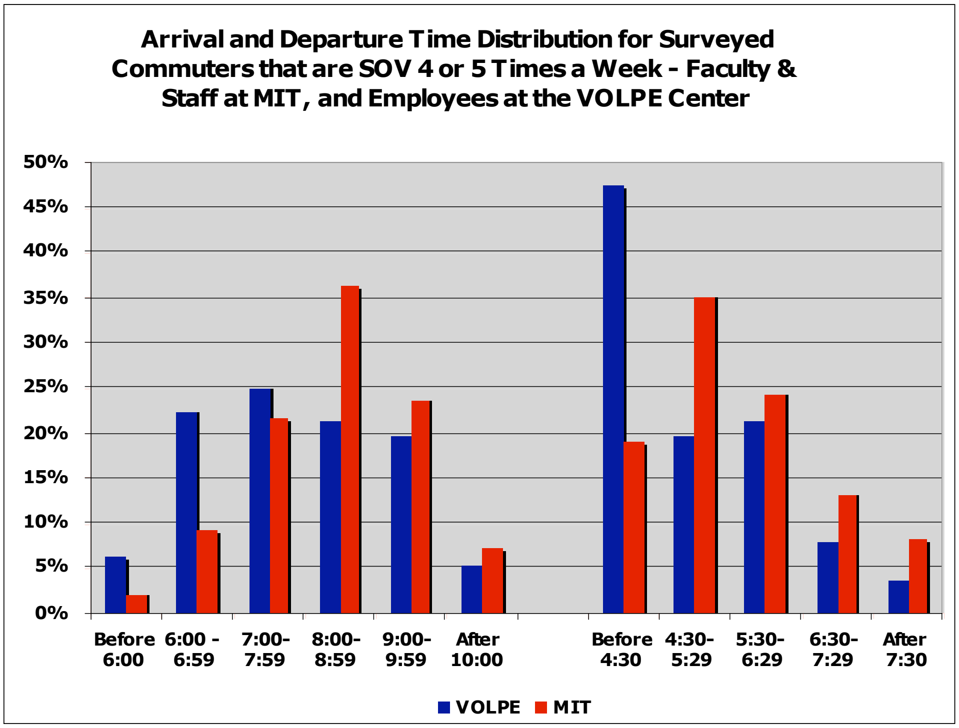




Source: Authors Analysis of MIT, 2008 & US Dept. of Transportation, 2009

### 7.6.3 Considerations for Inter-Institutional Ridesharing: Arrival & Departure Times

As the introduction to this chapter highlighted, one of the goals of this analysis was to make the case for an inter-institutional rideshare trial in the Kendall/MIT area of Cambridge, MA. The analysis of commuter behavior at MIT and VOLPE has shown that the potential for increased ridesharing is favorable at each institution individually, but that additional analysis of arrival and departure times may be needed to determine whether inter-institutional rideshare opportunities are likely. Figure 7.17 presents the arrival and departure time distribution for MIT and VOLPE. Note that VOLPE tends to be an 'earlier' organization while MIT is 'later'. The difference is particularly pronounced in the afternoon, with nearly 50% of VOLPE employees departing before 4:30pm. It should be reinforced that VOLPE's departure times were calculated, rather than stated values. Since the survey did not ask employees when they departed the Center, it was assumed that all employees were present for exactly 8.5 hours. Further data collection and analysis would provide a better sense of how feasible inter-institutional ridesharing would be.

**Figure 7.17: Distribution of Arrival and Departure Times for Four or Five Day-a-Week SOV Commuters at MIT and VOLPE**




Source: Authors Analysis of MIT, 2008 & US Dept. of Transportation, 2009

## 7.7 Analytical Shortcomings

Many of the drawbacks of this modeling effort relate to the lack of detailed information on commuter behavior and the impact that has on the accuracy of the model. Both analyses assume that commuters make direct trips to and from home. In reality, trip chaining is quite prevalent and reduces the number of commuters that can reasonably be assumed to rideshare. Additionally, intra-week schedule variability is quite common. Commuters may modify their departure times based on various home or work commitments. The MIT survey only asked for arrival and departure times to/from campus on a typical day. A third shortcoming specific to the VOLPE analysis was the 60-minute interval for arrival and departure times. This interval is simply too wide to safely assume that partners would consider sharing a ride with one and other. None of these real-world commuting characteristics were considered due to a lack of detail in the MIT and VOLPE surveys.

Further, this analysis has focused on two large institutions. In many ways, the physical location of MIT and VOLPE and the transport options available to their community members are unique. While the results are important for the respective institutions, they may not necessarily transfer to other subsets of the MIT and

VOLPE communities that did not complete the survey, or to other institutions in other physical settings. Therefore, the results of this analysis should be considered specific to MIT and VOLPE.

## 7.8 Conclusions

This chapter has outlined a methodology for estimating rideshare potential, and has sought to demonstrate its applicability using the MIT and VOLPE communities as case studies. Previous studies have relied on hypothetical metro areas, or GIS-based techniques to determine likely rideshare potential. This study has aimed to improve upon previous research by assigning trips to a particular route and determining likely rideshare matches by applying different constraints on drivers and passengers. Whereas previous studies have found that ridesharing may be able to reduce metro-area emissions and VMT by 0.4% - 2.0%, this analysis has found that VMT reductions achievable among the MIT commuting population to be between 9% and 27%, and reductions among the VOLPE community to be approximately 6%. The MIT analysis suggests that ridesharing is a robust travel option for many commuters, and that rideshare participation may be improved by providing community members with information on rideshare services and potential rideshare partners. The combination of the MIT and VOLPE analyses suggest that the different arrival/departure time profiles for the two institutions may limit the amount of inter-institutional matches.

## 7.9 Next Steps

The results from this analysis have been very informative, but as mentioned earlier, it is not clear that residential locations and commuting behavior among members of the MIT and VOLPE communities are representative of the wider Cambridge area. To improve the applicability of these results, it is hoped that similar analyses can be undertaken with other large institutions in the MIT/Kendall Square area. Ultimately, it is hoped that a series of market 'viability' analyses of rideshare potential for multiple organizations in the Kendall/MIT area can be used to design a targeted, comprehensive, technology-driven rideshare trial for this portion of Cambridge, MA.

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# Chapter 8: Designing a Real-Time Ridesharing Trial for the MIT Community

The content of this chapter is a synthesis and application of the information covered in chapters one through seven. Having identified the major challenges associated with ridesharing, having looked closely at the motivations for sharing rides, and having estimated the potential for ridesharing among MIT community members, this chapter aims to synthesize that knowledge into the design of a rideshare trial. The trial design presented is technology-based, employer-focused, and aimed at the MIT community specifically. It capitalizes on MIT's penchant for developing and using innovative technologies. While the trial focuses on the particular circumstances of the Institute, the features can be applied to other organizations. This is important, as the ultimate goal is to implement an inter-institutional rideshare initiative among multiple large employers in the Kendall Square/MIT area of Cambridge, MA.

As this trial design is considered, it is important to think of it as one small component of a wider improvement in transportation services across the Institute, rather than as an isolated rideshare trial. In the coming 12-18 months, many opportunities exist to re-consider how transportation services are offered at MIT. Beginning this upcoming academic year, the cost of the annual 'Commuter' parking permit will be the same as the 'Occasional', daily use permit for the first time. This provides an excellent opportunity to move to exclusively 'pay-by-the-day' parking, which on its own may reduce SOV commuting. The Institute is currently testing an MIT identification card with an integrated MBTA "Charlie Card" chip that will allow for integrated parking and transit access, and is a preliminary step towards implementation of the MIT Mobility Pass concept. The MBTA themselves are moving forward with the release of real-time transit information in an effort to improve the passenger experience. Further, the Commonwealth of Massachusetts will be undertaking a four-year reconstruction of the Longfellow Bridge beginning in 2011, reducing access to a portion of Cambridge, MA. These situations combined will affect multiple modes of transportation around MIT. This opportunity should be used to encourage commuters to re-evaluate many of their existing travel choices and specifically consider ridesharing.

The trial design integrates five key features into a comprehensive service. They include:

(1) <u>Smart Phone Technology & "Real-Time" Services</u>: The use of smart phones and advanced, "real-time" services provide participants with a variety of rideshare trip types to choose from. The

technology also enables improved data collection for the provision of incentives and performance measurement.

(2) Personalized Travel Planning & Marketing: The MIT Commuter Survey, focus groups and potentially a smaller, focused survey are used to identify commuters interested in ridesharing or alternative modes of transportation more generally. The information gathered is used to provide personalized travel plans and potential mode choice options.

(3) Comprehensive Package of Incentives: Special consideration is given to the types of participant likely to take part in the trial, and their motivations for doing so. Incentives for drivers focus on reduced parking costs, while incentives for passengers focus on transit discounts and financial rewards for sharing rides.

(4) Provision of Multi-Modal Information: The trial proposes the development of a transportation information system, accessible through the web or on a smart phone, that integrates rideshare information with transit information, Zipcar availability, MIT shuttle bus information and possibly taxi availability.

(5) Data Collection & Performance Measurement: The trial places a strong emphasis on the collection of data and measurement of performance, especially the successful completion of rideshare trips, in an effort to build upon the shortcomings of previous rideshare trials.

The key trial features described above, as well as a number of smaller features included in the trial design begin to address the main challenges associated with ridesharing, as they were described in Chapter 5. Figure 8.1 shows which trial features address the main rideshare challenges. Note the particular importance of the employer-focused, closed-system approach.

**Figure 8.1: Matrix of Rideshare Challenges and how the MIT Trial addresses them**

**How the MIT Rideshare Trial Addresses the Primary Rideshare Challenges**

| Rideshare Challenges | MIT Rideshare Trial Features | Employer Focused | Web & Smart Phone-based | Multiple Trip Types | Real-Time Information | Incentives | Personal Travel Planning | Focus Groups | "Critical Commuter" | Etiquette Handout | Pre & Post Trial Survey | Open API |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Economic Challenges | Economic Distortions | | | | | ☑ | | | | | | |
| | Imperfect Information | | | | ☑ | | ☑ | ☑ | | | | |
| | High Transaction Costs | | ☑ | | | | | | | | | |
| Social / Behavioral Challenges | "Stranger Danger" | ☑ | | ☑ | | | | ☑ | | | | |
| | Reliability of Service | ☑ | | | ☑ | | | | ☑ | | | |
| | Schedule Flexibility | | ☑ | ☑ | | | | | | | | |
| | Consistency of Expectations | | | | | | | | | ☑ | | |
| | Lasting Behavior Change | | | | | | | | | | ☑ | |
| Institutional Challenges | Institutional Collaboration | ☑ | | | ☑ | ☑ | | | | | | ☑ |
| | Business Model | ☑ | | | | | | | | | | |
| Technological Challenges | Measuring Successful Trips | | ☑ | | | | | | | | | |
| | Common Database Specification | | | | | | | | | | | ☑ |

## 8.1 Trial Goals

There are a handful of primary goals that this trial attempts to fulfill. They include:

(1) Demonstrate that technology-enabled ridesharing can successfully encourage greater occasional rideshare trips, in the context of a large employer

(2) Demonstrate that ridesharing complements other modes of transportation used by staff and faculty at MIT, ultimately reducing VMT to campus and reducing the need for parking on campus

(3) Demonstrate that institutional collaboration between different stakeholder groups can result in a successful trial for participants, providers, the Institute and other stakeholders

(4) Test the effectiveness of personalized travel planning and different types of incentives on rideshare behavior

Based on the results of an initial trial, additional goals could be considered.

(5) Through the recruitment of other large employers in the Kendall Square/MIT area, demonstrate that technology-enabled, inter-institutional ridesharing can be successful

(6) Evaluate the effects of simultaneous improvements in ridesharing and transit (through the use of the MIT Mobility Pass) to determine how commuters in different geographic locations throughout the Boston metropolitan area alter their choice of travel modes

(7) Evaluate household auto use when a rideshare participant leaves their vehicle at home during the day

The outlined goals are ambitious, but structured in such a way that they can be tested in phases. The primary goals are the critical ones to focus on initially, and if there is a sufficient level of success the secondary goals could also be considered.

## 8.2 The Value Proposition for Stakeholder Groups

Various stakeholder groups will have important roles to play in the successful implementation of an MIT rideshare trial, and are likely to derive some value from being involved. The focus here will be on the value proposition for key stakeholders. If successful, the trial could be expanded and might include other stakeholders including local employers and MassRides, the statewide rideshare coordinating agency. In this initial trial design, the value proposition for these groups will not be discussed.

### 8.2.1 MIT Commuters

The value of this rideshare trial for existing rideshare participants is mainly the ability to take advantage of the incentives provided, while not being inconvenienced by changes in parking policies. Some may argue that existing rideshare participants should not be included in the trial because their behavior already mimics what the trial is attempting to promote. However, there are a number of reasons to include existing rideshare participants. First, this group is already sharing rides and is likely to continue to do so. They form a core group of individuals that will almost always offer rides, or seek rides and may be willing to accept an extra participant every so often. Second, they are an important group of rideshare proponents that may be willing to encourage others within the Institute to share rides. Excluding them from participation (and the benefits of participation) may harm marketing and promotion of the trial. Third, their travel behavior can be analyzed in much the same way that other participants behavior will be. The results may reveal interesting differences between those that typically share rides and those that do not.

The value proposition for non-rideshare participants is largely to decrease the perceived costs of transportation. If the Institute switches to “pay-by-the-day” parking charges, the perceived costs immediately increase for all those participants that have a ‘Commuter’ permit. By offering incentives to increase the desirability of ridesharing, drivers have the option to continue driving for a lower perceived cost, if they share a ride. Passengers that switch to sharing rides rather than driving alone have significantly reduced their perceived cost of driving by leaving their vehicle at home, but have taken on what is seemingly a less desirable mode of transportation. It is this group of commuters whose behavior will be the most difficult to change. Passengers that choose to share rides rather than take transit are rewarded with what is presumed to be a more convenient, or quicker, trip. Since this group is already using an alternative travel mode, they are not explicitly targeted but may still obtain value from the trial.

### 8.2.2 MIT Administration

From the Institute’s perspective, the ceiling that has been imposed by the City of Cambridge on the number of parking spaces allowed on campus makes the existing spots a valuable asset. This is a function of the fact that parking is in high demand. Yet, any future building construction that is to take place will likely be on un-built land currently being occupied by surface parking. The loss of those spaces is interpreted as the loss of a valuable asset that must be outweighed by the benefits of new building construction. The 'compromise' has recently been to proceed with building construction but to include costly underground parking. If, however, the demand for parking were not as substantial, future building construction could occur without the perception of such a significant trade-off and the need to replace parking. Ridesharing is certainly not going to eliminate the need for all parking on campus, but it has the potential to eliminate the need for one or more surface lots, thereby allowing for higher-value building construction without the need for costly underground or third-party leased commercial parking.

Beyond the purely financial benefits to the Institute, MIT is interested in attracting new staff and faculty and improving the work experience for existing employees. The provision of a variety of transportation options in combination with personalized travel planning is a small but valuable benefit for employees that not all organizations can provide.

### 8.2.3 Rideshare Service Provider

The rideshare service provider selected for this trial obtains value through the demonstration of their service in the context of a large organization. Beyond the publicity that this sort of trial provides, the use of a "real-time" system will generate a substantial amount of information on commuter travel behavior and responses to incentives that the provider will be able to use to improve their service offerings. This data and user feedback from a population the size of the MIT community has tremendous value for a rideshare service provider, so much so that it may be possible for the Institute to negotiate a reduced rate for the use of the service in exchange for the service providers use of some of the commuter data. These savings could be used to offset the cost of providing smart phones to rideshare participants.

### 8.2.4 Smart Phone Provider

In the technology hardware market, the opportunity to have one's product used in a research setting at MIT carries some reasonable promotional value. This is particularly true when the devices themselves generate data that can be analyzed as part of an academic research project. Through a collaboration with the MIT Media Lab, for example, it may be possible to partner with a cellular handset provider such as Apple, Google or Nokia to receive free or reduced price smart phones for use in the trial in exchange for promotional opportunities and some use of the travel data that is generated.

### 8.2.5 City of Cambridge

The City of Cambridge has an obvious interest in seeing this trial succeed, as ridesharing reduces traffic congestion and emissions from private vehicle transport. The City relies heavily on its parking restrictions to encourage employers to reduce the transportation impacts of their employees travel; however, this trial offers the City an opportunity to work with MIT and possibly other nearby employers in a more collaborative, non-regulatory way on reducing transportation impacts.

### 8.2.6 MBTA

The MBTA may be hesitant of a rideshare initiative at MIT, as transit and ridesharing are often viewed as competing services. However, the integration of a ridesharing initiative with real-time transit information and the MIT Mobility Pass has the opportunity to increase transit ridership and revenue for the Authority, as demonstrated by Block-Schachter's thesis (2009). The provision of subsidized transit for those rideshare passengers that live near transit services is included in the trial design.

## 8.3 Institutional Capacity and Support

When designing a demonstration project, institutional capacity and support within an organization is critical, but often overlooked or taken for granted. Demonstration projects, or trials, by their very nature aim to test changes in the status quo. There will almost always be skeptics within an organization that will need to be convinced that the change is beneficial. The key is identifying strong advocates who support the demonstration and can convince others of its merit.

In a survey of employer-based rideshare initiatives in the UK, the Department for Transportation (2004) identified four key program characteristics that had the largest impact on participation and long-term rideshare success. They were:

(1) Parking enforcement, when rideshare vehicles were given preferential treatment,

(2) A committed and motivated program manager, with time and financial resources available,

(3) Strong senior level support within the organization, and

(4) Rideshare advocates throughout the organization, often division or departmental transportation coordinators.

Note that three of the four critical success factors are institutional in nature and speak to the need for strong support throughout the organization.

If a rideshare trial is likely to be successful at MIT, support will be needed from within the Parking and Transportation Office, but also from higher levels within the Institute. This support comes in two forms; a strong and committed team that will manage the trial, and Institutional commitment to provide the needed human and financial resources to successfully run a comprehensive trial. The recruitment of a dedicated team within the organization may require some effort, but MIT is a dynamic institution with no shortage of passionate people. Ideally, a single individual would be put in charge of rideshare trial development and would oversee implementation, support departmental efforts to increase ridesharing, analyze incoming data, track different performance metrics, and work with a variety of groups within the Institution including the Transportation and Parking Office.

The dedication of human and financial resources is likely to be more challenging, particularly for an endeavor that is relatively innovative. This is a classic 'catch-22' in new trials. Since there is some hesitancy of the trial's likelihood of success, there may be some unwillingness to devote substantial resources to the effort; however, without adequate resources the trial cannot be fully implemented and trial results will not reflect the full potential of the trial design. Data collection and feasibility studies, such as the analysis performed in Chapter 7, can help demonstrate the potential of ridesharing at MIT, but ultimately they cannot replace a strong commitment of human and financial resources.

Institutional support also needs to be developed within individual departments. Given the size of the potential population of rideshare participants at MIT and the importance of personalized marketing techniques, it will be very difficult for a single person or even a small team to provide information and answer questions from all staff and faculty. Training departmental parking coordinators to work more closely with employees will be required. Parking coordinators are currently responsible for communicating transportation information to their departments and are often the individuals that field day-to-day transportation questions and concerns. All of the coordinators act in a part-time capacity and have other primary roles that they fulfill within their respective departments. Some are likely to be hesitant of a new level of responsibility, particularly if there are no additional benefits offered for the extra effort. Some thought will need to be given to the time constraints of existing coordinators to contribute to a large rideshare initiative.

## 8.4 Rideshare Service Technology & Features

The selection of an appropriate rideshare service provider requires some careful thought. The discussion that follows outlines potential types of shared trip that the Institute may want to offer, and important features for a rideshare trial at MIT. There may a temptation on the part of the Institute to want to develop a custom-made system in-house that meets staff and faculty needs. This author advises against this approach for two key reasons. First, the number of rideshare service providers in the market has grown in recent years and it is more than likely that one of the existing services meets most or all of MIT's needs. There is no sense developing an application, particularly when the service already exists and when the technological aspects of the trial are one component of many that influences participation. Second, one of the goals of the trial is to demonstrate how institutional collaboration can lead to an effective rideshare trial. The development of a custom-made service undermines this goal.

### 8.4.1 Rideshare Trip Types to Consider

One of the first service aspects to consider is what types of rideshare trip should be offered to the MIT community. Four rideshare trip types are outlined below with a discussion of how they are used, the assumed attractiveness of each from the point of view of the driver and passenger, and some benefits and drawbacks of each trip type.

> "Real-Time" / Immediate: In "Real-Time" or Immediate trips, drivers are assumed to post their availability shortly before or upon entering a vehicle and passengers post their desire to share a ride minutes or hours in advance. In many ways, this trip type resembles a taxi service. The arrangement is valuable for passengers in an emergency situation, or with few travel options, but it is not clear what the benefit is for drivers. Previous research by Deakin, Frick and Shively (2010) suggests that this type of trip is not that sought after by commuters because it is perceived as unreliable and does not provide enough advanced notice to make alternate travel arrangements when a ride match cannot be found. Many "real-time" rideshare providers offer this type of trip.

Occasional: In Occasional trips, drivers and passengers are reminded daily at a fixed time (eg: 11am) to post their shared ride availability for the afternoon commute. The system gives participants 3 hours to post their ride availability. At 2pm, matching is performed for all of those participants that posted their availability; those that are successfully matched are provided with their partner's information, and those that are not are provided with information on alternative commuting options. A similar process is undertaken for morning trips, but the matching is done the day before. It is believed that this type of trip would be more attractive from a commuter's standpoint, as it allows for some schedule flexibility, but provides enough advanced warning to make alternate arrangements if needed. If drivers and passengers are selected appropriately, both participants should have an interest in this type of trip. Unfortunately, there are no known providers offering this 'timed match' occasional trip at the moment.

Traditional / Long Term: Traditional, or Long-Term, rideshare trips are typically recurring and long lasting. Generally, cost sharing is sorted out among the participants ahead of time, or informally though alternating driving responsibilities. The perception is that there are relatively few opportunities to encourage more of this type of trip, as those participants that see exceptional value in sharing trips multiple times a week would already have sought out a long-term partner. While these arrangements are the most common type of ridesharing, they are particularly hard to measure because once established, participants have no reason to log into a ride matching system. It should be possible to create a system that provides incentives to these participants that encourages the continual logging of trips. Most services generally offer this type of recurring/standing offer trip.

Out-of-Town / Special Events: Out-of-Town or Special Event trips are essentially a type of "occasional" trip, but they are generally not recurring. Inter-city weekend trips and shared rides to the airport during school breaks are two examples of where this type of trip may be used. This is likely one of the few trip types that would appeal to students. For drivers and passengers, plans are generally known further in advance than for commuting trips, meaning that ride offers/requests can be posted earlier. In the same vein, the need to know whether a shared ride is available also is desired further in advance. Many existing service providers offer this type of trip.

Ideally, the service provider selected would be able to accommodate “occasional”, “traditional”, and “out-of-town” trip types. While the demand for “real-time” trips is likely to be low, many providers offer this functionality already, so including it should not alter the cost of the service dramatically. In many cases, services that offer “real-time” trip functionality ought to be able to accommodate all other types of trip with varying degrees of effort. The “occasional” trip essentially mimics the “real-time” functionality, but rather than searching for ride matches whenever a new trip is posted to the database, matching only occurs at specific points in time. “Traditional” trips are more challenging, but can be thought of as a recurring “occasional” trip with a preferred (or pre-selected) partner. The “out-of-town” trip uses the exact same functionality as the “real-time” trips, the only difference being that the window of matching opportunity (or the length of time before the trip ‘perishes’) is generally longer.

### 8.4.2 Critical Service Features

The rideshare service offered to staff and faculty at MIT should have a number of key features. Since the focus of this trial is on demonstrating how technology can be properly incorporated into a comprehensive rideshare initiative, the use of smart phones is a prominent feature. Ideally, MIT community members will be able to post shared ride opportunities using the Web or an Internet-connected smart phone. In addition to having a constant Internet connection, the selected smart phone should have integrated GPS that can automatically locate participants without requiring manual user input. The integrated GPS feature allows a service provider to confirm that passengers shared a ride, and determine over what distance they shared the ride. This GPS functionality can determine when the matched participants are within close proximity to one and other, and confirm that the trip is underway by requiring both participants to type in a personal code. This confirmation feature also triggers the distribution of incentives. The use of smart phones also allows for greater scalability in the future. If additional organizations in Cambridge, MA were asked to join a larger area trial, the use of smart phones would allow them to be quickly integrated.

When using the service for the first time, participants should be able to create a detailed profile that can be saved and retrieved easily for future trips. Stored profiles should include common trips, such as “Home to Work” to reduce participant input time. When logging a rideshare offer or request, participants should be able to quickly select their trip from their stored profile. In addition, participants should be allowed to specify how long they would like their offer/request to be active, or in other words, when their offer/request should expire. If no match can be identified by the specified time, the system would contact the participant and inform him or her that their trip offer/request had expired before any suitable matches could be found. The self-selected expiry would override default values built into the system. For example, a "real-time" trip might have a maximum window of opportunity of two hours. "Occasional" trips would expire at the next preset, 'timed match' period. The logging of a rideshare trip should also allow participants to select a preferred partner, or someone that they have ridden with previously. In order for that pairing to occur, both participants would have to log their desire to share a trip and at least one would have to specify their desire to ride with the other. While the likelihood of this scenario seems minute, this would be a useful feature for "traditional/long-term" rideshare participants, if they can be incentivized to log their recurring trips. For all trip types, the pairing up of participants should be done automatically, with partner information being sent with a simple message asking both partners to accept or decline the matched trip.

To the degree possible, the service should be customized for MIT staff and faculty. If it is possible to use information from the MIT personal certificates, this option should be explored as one method of reducing the amount of user input needed when registering for the service and when logging into the service each day. Web access for MIT faculty and staff could be through the "Inside MIT" web portal, a personalized website that brings together multiple forms of personal information in one virtual location.

The service should be integrated with information on other modes of transportation, so that in the event a ride partner cannot be identified, information on other modes of transportation can be provided to the participant. The specific modes to integrate and the availability of data will be discussed in the following subsection. An absolutely essential back-end feature for the service is the automatic confirmation that a trip has occurred, using the integrated GPS in the smart phone. The trip confirmation feature is critical both for the fair distribution of incentives and for performance measurement.

While some may debate this point, this author does not believe that driver certification or a participant rating feature are needed for an MIT trial. Both of these features are used to mitigate safety concerns when traveling with an unknown partner. Since the trial is initially being designed as a closed-system, accessible only to the MIT community, it is believed that safety concerns will be small. In the event the trial is expanded to other Kendall Square/MIT organizations, these features may be more valuable. To the degree that a particular service provider offers these features, and they can be incorporated into the service in the future, it would make expansion of the trial relatively simple.

### 8.4.3 Provision of Multi-Modal Information

The provision of information on other modes of transportation is an essential feature of the service. Commuters are multi-modal and will consider different travel options based on their specific needs. The ability to provide participants with information from multiple sources in a single application is very desirable from a participant's perspective. Modes that should be considered in a multi-modal information system include MBTA bus and rail services, taxi, Zipcar and MIT shuttle bus information. Note that there is no requirement that this particular feature of the system be limited to only those participating in the trial. This type of multi-modal trip planner could be quite valuable to other commuters within the Institute and to others in the Boston area.

The MBTA has made all of their bus and train schedule data available through Google's GTFS data specification. This should allow for rather simple integration of scheduled bus and train information. The MBTA is also working on providing customers with real-time bus information, although this information is probably only useful for those seeking a ride imminently, perhaps 20 minutes or less, otherwise schedule data is probably more reliable.

The ability to locate an available taxi, or request a pickup through a smart phone interface would be ideal but it does not appear that such a service exists in Boston at this time. Much of the Boston area taxi fleet is GPS-enabled so the ability to provide customers with real-time taxi information appears to be possible. This is of course contingent on the taxi providers being willing to share that information. The use of GPS to track taxi cabs in New York has led to the development of several different smart phone applications that provide improved taxi information. One such application shows users where they are most likely to find an available taxi (Cabsense, 2010), and another one provides users with the ability to request a taxi through a smart phone interface and than search for other travelers that may want to share the taxi with you (Weeels, 2010).

For travelers making a quick roundtrip from the MIT campus, the use of a Zipcar may be the quickest means of travel. Zipcar currently has seven vehicles on campus and an additional 29 in the surrounding area (Zipcar, 2010a). Additionally, they have developed an application for the iPhone that allows users to locate and reserve their vehicles while away from their computer. Depending on the provider and smart phone hardware selected, it may be possible to link the MIT multi-modal feature to the Zipcar application.

Finally, real-time location information for MIT campus shuttles should be integrated. For commuters that park in lots on the west side of campus, real-time information on when the next shuttle is expected to arrive could be quite useful for traveling to and from the central or eastern part of campus. The real-time information is provided by a well-known transportation data firm named NextBus, suggesting that data integrate with information on other modes of transportation should not be too difficult.

### 8.4.4 Common Data Standard

Although the MIT trial is initially being designed as a closed-system, accessible only to the MIT community, choosing a provider with an open API is certainly preferable for future expansion. An open API would allow organizations using a different rideshare provider to access MIT's available shared ride opportunities, if they were granted access to do so. While not a critical feature for the initial trial, this is a rather important feature that allows for future inter-institutional ridesharing opportunities. It is also a relatively simple method of ensuring that access can be provided to MIT's system in the future, without having to undertake a detailed review of all other local-area provider systems at the outset of the trial.

## 8.5 Marketing & Promotion

Marketing and promotion is another critical feature that is frequently overlooked in the development of rideshare trials, yet has proven to be critical to the success or failure of past technology-enabled efforts. There is evidence that MIT community members may be willing to share rides if better information was provided to them. In the 2006 MIT Commuter Survey, over 300 community members stated that they would consider ridesharing if it was easier to find a suitable partner (MIT, 2006). The following section will outline important marketing and promotional approaches that should be included in the design of the trial.

### 8.5.1 Targeting MIT Community Members for the Trial

There are several approaches that can be used to select participants for the trial. A largely random approach can be employed, whereby any participant that expresses an interest can be included. A much more strict approach would be to limit the trial to those who had some significant rideshare potential in the viability analysis outlined in Chapter 7. There are trade-offs between the two approaches, meaning that some form of compromise is likely to be the best option. If anyone who expresses an interest is allowed to join, it is quite possible that SOV commuters with few rideshare opportunities would be included in the trial, leading to an inefficient use of resources. On the other hand, if the trial was limited strictly to the community members identified in the viability analysis, some potential participants may be accidentally excluded. Additionally, others within the Institute may view this strict approach as arbitrarily exclusionary.

A balance between the two may be to target those participants in the Commuter Survey that are either existing rideshare participants, or are frequent SOV commuters. Figure 8.2 shows this subset of the MIT population. In total, some 818 community members share rides over the course of a week and would likely continue to do so during the implementation of the trial. This group should not be considered the main focus of the trial, but rather a portion of the MIT population that would likely participate without too much marketing or promotional effort. The 1,247 commuters that travel alone by vehicle four or five days a week is the subset of the MIT community that should constitute the main focus of the trial.

**Figure 8.2: Number of Potential MIT Participants by Mode of Travel and Frequency of Use, 2008**

| Number of Potential MIT Trial Participants by Mode of Travel & Frequency of Use, 2008 | | | | | |
|---|---|---|---|---|---|
| Number of Times | Existing Shared Transport Participants | | | | Existing SOV Commuters |
| Used per Week | Carpool | Vanpool | Share-and-Ride | Dropped Off | SOV 4/5 Days a Week |
| 1 | 98 | 8 | 52 | 56 | |
| 2 | 70 | 5 | 26 | 17 | |
| 3 | 66 | 9 | 30 | 7 | |
| 4 | 60 | 4 | 35 | 9 | 333 |
| 5 | 171 | 10 | 67 | 18 | 914 |
| **Total** | **465** | **36** | **210** | **107** | **1247** |

Source: Author's Analysis of MIT, 2008

Of course, the survey only covered a portion of the MIT community, so some method of identifying other potential participants may be needed. The simplest way to do this would be to add in the remaining 'Commuter' and 'Carpool' permit holders that did not complete the 2008 survey. While this approach does continue to target those community members that are the most likely to share rides, it requires that additional information be gathered on this group's existing travel preferences, so that some estimate of mode split changes can be calculated in the middle and at the end of the trial. The 2010 MIT Commuter Survey will be administered in the coming year and provides a good opportunity to overcome this need for supplemental information. Prior to the release of the 2010 survey, community members could be informed of the trial and told that if they would like to be considered they would have to complete the survey. This, in combination with a number of additional rideshare related questions, could eliminate the need for a supplementary survey altogether. Further details on the supplementary survey and potential rideshare questions that could be added to the 2010 survey can be found later in this chapter.

If the trial were opened up to a wider audience in the future, some additional constraints would need to be placed on those who are considered eligible to participate. To the degree possible, pedestrian, cyclist and transit commuters should be eliminated from consideration. Establishing a threshold, say three miles, and eliminating any commuter within that distance to campus may accomplish this in a rough way. There is also a question of how to handle rideshare participants that share rides with an individual not affiliated with MIT, such as a partner or employee from another organization. For the purposes of the trial, these types of shared rides should probably not be counted or given credit, based largely on the complexity of incorporating this group into the trial. If the system were to be used more widely in the future, one potential option would be to allow existing MIT participants to invite individuals from outside the Institute to participate. The invited individual would only be allowed to share rides with the participant that invited them. Since the trial has been designed to work with smart phones, the invited individual would need to have a compatible smart phone. The MIT participant should still receive incentives for their participation; it is not clear whether the non-affiliated individual should be eligible to receive them.

### 8.5.2 Focus Groups with Community Members Living in the same City/Town

A relatively simple first step in promoting the benefits of a rideshare trial and gauging community member interest would be to organize small focus groups of staff and faculty members that live in the same city or town. Small groups could be asked about their travel preferences, and what sorts of incentives they would consider desirable. Most importantly, the small focus groups would allow community members to introduce themselves and meet one and other. These introductions act as an important chance to meet potential rideshare partners without the need to commit to sharing a ride with them.

### 8.5.3 Personalized Travel Planning and Marketing

Personalized travel planning and marketing is another key feature of a rideshare trial at MIT. Some recent research reviewed in Chapter 3 has highlighted the potential of providing commuters with more information and recommendations on how to change their travel behavior. For the trial, those participants whose participation would be desirable could be provided with a one-page document outlining their travel options to MIT, including cost, estimated travel time and environmental impact. These documents could be form-based, and populated with data from a variety of sources including Google Maps, the MBTA and the rideshare analysis conducted in Chapter 7. For those participants with rideshare options available, the number of fellow community members that they could share a ride with would be included. Community members would be encouraged to contact the rideshare trial team for more detailed travel suggestions. If the results of the personal travel planning efforts in this trial were successful, the Institute may consider extending them to a wider range of community members.

### 8.5.4 The "Critical Commuter"

For those towns where there are a large number of SOV commuters (Lexington and Waltham, for example), the Commuter Survey and focus groups may identify drivers that travel on a reasonably consistent basis at peak arrival and departure times, and are willing to share rides with passengers. These are "critical commuters". If these community members can be encouraged to offer daily rides to central locations in their community (such a commuter rail stop, or town square), they effectively constitute a type of shuttle, or mini-vanpool, to and from MIT. Potential rideshare passengers would certainly view the reliability of such an arrangement very favorably.

### 8.5.5 Other Marketing and Promotional Activities

In addition to the more personal marketing approaches described, various general promotional activities would need to be undertaken. A brand and/or slogan for the rideshare initiative would help with marketing and recognition among the target group at MIT. While flyers and posters may not be suitable for a trial targeting a very specific group of participants, e-mail reminders and branded memorabilia could be used.

A high profile "trial launch" would ensure that participants see that the Institute is committed to the trial. It would also give participants yet another opportunity to see potential partners face-to-face. The launch could be coupled with an initial "try ridesharing for a week" campaign that would encourage those that are still somewhat skeptical to try sharing rides. Since initial impressions are important in social encounters, high levels of participation and successful matches at the outset would establish strong positive views from participants.

MIT would also want to provide rideshare participants with a 'handbook' outlining the benefits of ridesharing and what constitutes appropriate behavior in a rideshare arrangement. Rideshare etiquette varies widely, based largely on driver preferences, but some basic recommendations highlighting the importance of being on time, having a clean vehicle, avoiding excessive cell phone use, etc. would be helpful in establishing desirable behavior at the outset.

## 8.6 Incentives

Incentives have been used extensively in rideshare arrangements as a method of enticing commuters to share rides. Since the economics of vehicle travel do not provide much incentive to maximize occupancy (most automobile costs are “sunk”, fixed expenses), incentives act as a second-best solution. One of the most challenging issues with the provision of incentives is their high cost, and the tendency of stakeholders to reduce or eliminate them during budget reviews. Highlighting the cost of incentives, a UK firm by the name of PowerGen instituted a rideshare program for their employees that led to a 13% reduction in SOV mode share, with nearly 75% of their total budget being spent on the provision of incentives (UK Department for Transportation, 2004). This section will propose a combination of incentives for participants in the trial, with particular consideration given to the different motivations of drivers and passengers.

### 8.6.1 Revisiting Driver and Passenger Motivations

Section 8.2 briefly touched on the assumed motivations of different groups of trial participants, but it is worth considering them again in some detail before the incentives are presented.

Existing rideshare participants in the trial would essentially seek to be made no worse off than they are currently. As long as the cost of parking remains the same, this group will likely continue sharing rides with little or no additional incentive needed. To the degree that additional incentives are offered, this group may choose to share rides more frequently than they have done in the past.

Participants that are currently cyclists or transit users that show a desire in participating are likely seeking to improve the convenience of their commute. Since this group is already using a sustainable form of transportation, they should not be actively recruited, but they need not be actively discouraged either. Since this group of commuters is believed to be benefiting outright through the improved convenience of the trip, no additional incentives should need to be provided.

The target group of commuters are those that currently drive alone, but are being encouraged to share rides. There are two distinct groups here; those who are currently SOV and are being asked to accept a passenger, and those who are currently SOV and are being asked to give up their vehicle and become a rideshare passenger.

For those who are still being encouraged to drive, but to offer rides to others, the behavior change being sought is relatively small. The driver continues to use their vehicle and continues to choose when to travel to and from campus. They may be asked to increase their travel time slightly, but in general they are not being asked to change their behavior substantially.

For those being encouraged to switch from driving in their own vehicle to riding in someone else's, the behavior change being sought is substantial. This passenger can no longer travel when they please; they are subject to the driver's schedule. They're traveling in someone else's vehicle, subject to the other person's habits and preferences. Finally, there's always the small chance that the driver may have to leave for an emergency and leave the passenger stranded.

These assumed motivations are important to remember as the incentives section of the trial is described.

### 8.6.2 The Opportunities and Drawbacks of Providing a Free Smart Phone

From the participant's perspective, one of the greatest incentives to participate is the use of a free smart phone. From the perspective of the Institute, the use of a smart phone involves some trade-offs.

The use of smart phones creates some valuable opportunities. It provides a strong incentive to participate, so it is believed that a reasonable number of community members would show some interest in the trial. More importantly, the devices capture a large amount of valuable travel data including the confirmation that a rideshare trip has taken place. This data is of potential value to a number of different stakeholders.

But there are a number of drawbacks as well. The data collected is substantial, raising a number of privacy concerns. Further, the provision of the phone does not guarantee that participants will actually participate in the trial. Some may take the opportunity to receive a discounted phone and choose not to offer or request rides. Some requirement could be established linking the monthly subsidy provided for the phone (described in the next paragraph) to the amount of participation each week, but this would call into question how much of the observed behavior change was due to the 'required' smart phone use vs. actual perceived improvements in ridesharing. In some cases, participants may already have a smart phone and may feel that others that are receiving one are receiving preferential treatment. In these cases, the incentive to participate decreases.

There is also the issue of cost; it is more than likely that providing smart phones will be the single largest trial expense. If these devices were provided at full cost for a period of a year, they would amount to nearly $1,200 per participant. Sponsorship from a mobile phone provider such as Apple, Google or Nokia would partially offset this cost. The trial could also be designed to only cover part of the monthly usage charges. For example, trial participants could be reimbursed a minimum of $20/month, and up to a maximum of $80/month, based on the difference in prices of their current cellular plan and that required for smart phone use. If a participant does not have any phone at all, they would be reimbursed $80/month. Those currently with a $50 plan would receive $30/mth to offset the cost difference. Those with a $100 plan would receive the minimum $20/month. If one assumed that the cost of the device itself could be provided through sponsorship, and the average participant was provided with $40/month in operating subsidy, the total annual cost per participant would amount to approximately $500.

### 8.6.3 Incentives for Drivers – Changes in the Parking Fee Structure

Drivers in rideshare arrangements are likely to respond to decreases in their costs of parking. The question is one of how to encourage participation and ridesharing in exchange for decreased parking rates.

MIT currently offers two types of parking permits for SOV commuters; the ‘Commuter’ permit and the ‘Occasional’ permit. The ‘Commuter’ permit is an annual permit that is paid for at the beginning of the school year and provides unlimited access to a designated parking lot. The ‘Occasional’ permit is a “pay-by-the-day” permit ($50 annual fee + $4/day), but can still only be used in a designated parking lot. Currently, the ‘Carpool’ permit is a ½ price ‘Commuter’ permit.

The proposed change in the parking fee structure assumes that the Institute has eliminated the ‘Commuter’ permit and shifted all SOV drivers to the existing ‘Occasional’ permit scheme. This shift from a fixed, annual charge to daily charges on it’s own promotes less SOV commuting. Any participant that would agree to participate in the trial would agree to a slightly modified structure of a $50 annual fee plus $5/day for parking. The additional dollar would be to discourage drivers from accepting the smart phone, but than refusing to participate and continuing to drive alone. If the driver posted their availability to share a ride, they would be credited $0.50 on their parking fees, regardless of whether they were matched with a passenger. If they are indeed matched and accept the ride, another $1.00 is deducted. If they post their availability, are successfully matched with a passenger, but choose to decline the ride match, they forgo both credits and receive no parking discount. If drivers post their availability and are matched on both the trip to MIT and the return trip home, they reduce their daily parking rate from $5 to $2.

The first credit is to encourage the posting of rides. This helps ensure that there is a reasonable amount of vehicle 'supply' for interested passengers. The second credit, in combination with the potential loss of both credits if a ride is declined, ensures that the driver accepts the ride and is not trying to game the system. The final decision on what the value of the two credits should be is a balance. If the first credit is too small, not enough rides will be posted. If it is too large, there will be too many participants seeking to be drivers and not enough seeking to be passengers. Previous experience from the RideNow and Bellevue trials described in Chapter 3 suggest that there is more likely to be interest in driving rather than riding as a passenger, suggesting that the first credit should be smaller, and the second one larger. The absolute lowest parking fee of $2 for those that exhibited the most substantial behavioral change was chosen because it amounts to almost exactly the cost of an existing annual carpool permit, as shown in Figure 8.3. This means that traditional, long-term rideshare participants are made no worse off by the change in the fee structure.

**Figure 8.3: Cost Impact, from the Employees Perspective, of the Proposed Change in Daily Parking Charges**

| **Cost Impact, from the Employees Perspective, of the Proposed Change in Daily Parking Charges** | | |
|---|---|---|
| Existing: | Frequent SOV Commuter | Rideshare Commuter |
| Annual Parking Permit Costs (FY 2011) | $968 | $484 |
| Annual Parking Permit Costs (FY 2012) | $1,074 | $537 |
| Proposed: | | |
| Max Annual Cost with a Daily Charge (235 days) | $990 | $990 |
| Max Annual Cost, Daily Charge and Rideshare Incentive | $990 | $520 |
| Difference between the Existing & Proposed Charges, FY 2011 | $22 | $36 |
| Difference between the Existing & Proposed Charges, FY 2012 | ($84) | ($17) |

This incentive design is interesting in that it is equal to the benefit current rideshare participants receive, but in a slightly different form. The Institute currently offers the primary 'Carpool' permit holders an annual permit for ½ the price of a regular 'Commuter' permit and the secondary participant is not charged any fee. In essence, the incentive being offered for rideshare behavior is nearly the same, but the resulting level of success may improve. The added benefit of the $5/day initial charge coupled with the $0.50 credit each time the driver posts his or her availability means that even if the driver receives no match either in the morning or the afternoon, they would still pay $4/day for parking, the same as any other SOV commuter.

### 8.6.4 Incentives for Passengers – Free/Discounted Transit & Weekly Lottery

The incentives for passengers need to be slightly different, particularly for those passengers that are being encouraged to switch from being an SOV driver to a rideshare passenger where the behavioral change is significant. For those participants living near transit, a heavily subsidized or free transit pass could be offered. Ideally, the transit benefit could be structured as a form of Mobility Pass, whereby the Institute offers the permit for a fixed cost to the commuter, but only pays the MBTA for those rides that are taken. Since the permit is 'free' in the eyes of the commuter, they should be tempted to use transit more frequently than they would otherwise. However, since they've avoided using transit in the past, it is unlikely that they will substantially alter their behavior and become a frequent transit rider. There is some potential however, that this group might begin to use a combination of transit and ridesharing for their travels to and from MIT.

In an effort to encourage participants to take the role of passenger in rideshare arrangements, a weekly lottery system could be considered that rewards participants for both requesting a shared ride and for successfully completing a shared ride. For every rideshare request submitted, a participant would receive one point. If they are successfully matched with a driver, a second point is awarded. If a request is made and a match is found, but the passenger declines the trip, they receive zero points. At the end of the week, each point becomes a single entry into the weekly lottery, with a maximum of 20 entries per passenger per week. The lottery would be tiered, much like the Prabhakar trial described in Chapter 3, so that the highest tier (the one where behavior change has been substantial) has a small number of participants and a high probability of winning a high-value award. The next tier would have a larger number of participants, with a lower probability of winning a medium-value award, and so on. One can imagine a 3-tier lottery whereby those with 1-4 weekly points are eligible for Tier I awards, participants with 5-8 points are eligible for Tier II awards and participants with 9-20 points are eligible for Tier III awards. Tier I awards may include a free day of parking in a lot of the participants choice on an SOV day, a free hour of Zipcar use on rideshare days, or gift certificates to local businesses such as Legal Seafood. Tier II awards could include tickets to a Red Sox game offered through the MIT Activities Center. Tier III awards could include a $250 cash prize. It is unclear whether this sort of arrangement would ultimately appeal to passengers, so some flexibility in the design may be needed.

### 8.6.5 Preferential Rideshare Parking

The Institute could also offer preferential parking for rideshare participants, allowing them to park in the Stata or Sloan garages (or any lot selected for preferred parking privileges). Participants in the trial would continue to use the rideshare system as they normally would, posting ride offers and requests. When they arrived for the day, they would swipe their ID card and would be charged the full daily parking rate. Existing rideshare participants would also be supportive as it provides them with a better parking spot. This type of arrangement would not impact any plans the Institute is considering for differential parking rates by lot, as the driver is still charged the full amount at the point of entry. If differential parking rates were in effect, rideshare participants could receive the privileges of preferred parking, and the Institute could provide an additional incentive and only charge the driver the rate they would usually pay at their 'home' lot. For trial purposes, only those participating would be eligible to receive the benefit. Given the difficulties in predicting the number of shared rides on a given day, the Institute would have to decide if allocating a fixed number of spots on a "first-come-first-serve" basis with the risk of disappointing some rideshare participants that can not access their preferred lot would be acceptable. The alternative would be to 'over-allocate' spots based on the predicted number of rideshare vehicles (essentially guaranteeing a spot) but risk the underutilization of the lot. Some compromise, where a large number of spots are guaranteed until 9:30am at which point the unused ones revert to general use, is probably acceptable.

### 8.6.6 Guaranteed Ride Home

Much of the literature suggests that there is high value placed on 'Guaranteed Ride Home' benefits by rideshare participants, yet when it comes to actual use; very few participants register for these services or take advantage of them. Guaranteed Ride Home services provide commuters that rely on alternative forms of transportation (including ridesharing) with a guaranteed trip home in the event of an emergency. It is possible that participants do not understand that in most cases, one must register for these benefits, or it could be that they simply sign up and use it when they need it for the first time. Guaranteed Ride Home benefits are essentially a form of insurance; the fact that the service exists and will be available when needed is a psychological benefit, yet relatively few will need to use it.

Guaranteed Ride Home benefits are currently provided to MIT community members through the Charles River TMA. Unfortunately, the program requires that participants be using alternative modes of transportation at least three days a week in order to qualify for the benefits (Charles River TMA, 2010).

Since our target audience in this trial is commuters that rely primarily on SOV travel, Guaranteed Ride Home benefits will likely have to be provided by the Institute. For those participants that are within ½ mile of subway station, a free Charlie Ticket could be provided. For those with little to no transit access, taxi vouchers are more common. The Institute could also consider allowing participants to use a Zipcar in the event they are stranded. Zipcar currently offers overnight rentals between 6pm and 8:30am for $34 (Zipcar, 2010b). Based on Cambridge taxi rates, it would be more cost effective for participants traveling beyond Rt. 128 to use a Zipcar than a taxi (City of Cambridge, 2010). It does however mean that the passenger will need to return to campus with the vehicle the next day and hope that a return ride can be found.

## 8.7 Data Collection, Analysis & Performance Measurement

Data collection and performance measurement has been given insufficient consideration in previous technology-enabled trials. It is not entirely clear why this is the case, but it seems likely that there was insufficient consideration of data needs during the design phase of the trial. If so, this is an important shortcoming as the majority of the data collection and analysis takes place in the pre-implementation phase of a trial. Data requirements need to be thought through carefully at the beginning of a trial. This section outlines a variety of sources of information that can be used to identify desirable rideshare participants and measure performance throughout the trial.

### 8.7.1 Identify Rideshare Participants & Demonstrate Rideshare Viability

In the pre-implementation stages of the trial, the main goals of data collection and analysis should be to identify potential participants that would receive value from a rideshare arrangement, and demonstrate the viability of ridesharing. The demonstration of viability is particularly important, as past rideshare trials have had mixed success and there is likely to be some skepticism as to the benefits of further trials.

As mentioned numerous times throughout this chapter, the MIT Commuter Survey is a very good data source for determining the viability of ridesharing and identifying potential participants. The level of detail in the survey is such that for those commuters that completed it, a large amount of information is known on existing travel behavior and potential travel behavior. However, the survey does not cover the entire MIT commuting population (62% response rate) and cannot be used to identify all potential SOV commuters that could potentially rideshare. Further information from the Transportation and Parking Office, such as the list of individuals with a 'Commuter' permit, could be used to supplement the existing data.

With the upcoming release of the 2010 MIT Commuter Survey, an opportunity exists to add several rideshare-specific questions. If participation in the trial was limited to only those that completed the survey, including the rideshare-specific questions, relatively complete information would exist for all trial participants and the need for a supplementary survey would be largely eliminated. The following four questions, or variations on these questions, should be considered for inclusion in the 2010 survey.

(1) Have you previously used carpooling as a mode of transportation to work, whether to MIT or elsewhere?

a) No, have not carpooled to work previously

b) Yes, have carpooled to work previously

(2) If you previously carpooled, what are the main reasons that you do not carpool to work any longer? (Multiple answers are acceptable)

a) Have since changed work location

b) Have since changed residential location

c) Finding a carpool partner has been too difficult/time consuming

d) Can now comfortably afford to drive alone

e) Now have access to a personal vehicle

f) Have since changed my work/commute schedule

g) No longer receive sufficient time savings to justify it

h) Other: ________________________________________

(3) If you have not previously carpooled and are not currently carpooling, what are the reasons? (Multiple answers are acceptable)

a) My schedule is too variable, inconsistent day to day

b) Finding a carpool partner has been too difficult/time consuming

c) Prefer to be in control of my situation, want to have access to my vehicle in case of an emergency

d) Time savings do not justify the effort

e) Monetary savings do not justify the effort

f) My commute is not a straight trip; I often do errands along the way

g) I'm not comfortable having a stranger in my vehicle

h) Other: ________________________________________

(4) If MIT were to provide additional incentives, which of the following would most influence your decision to carpool? Please rank the incentives below as highly important, moderately important, or of low importance:

a) Discounts to local area venues (restaurants, sports events, arts events) [scale of 1-5]

b) Discounted Parking on days you Carpool [scale of 1-5]

c) Priority Parking / Preferential Choice of Parking Lot [scale of 1-5]

d) For every day that you carpool, you're entered into a $250 weekly lottery [scale of 1-5]

e) A Guaranteed Ride Home program [scale of 1-5]

### 8.7.2 Focus Groups & Pre-Trial Surveys

If the higher-level assessment of rideshare viability and participant identification demonstrates that there is a reasonable population that might consider ridesharing, further personalized data collection could take place. As mentioned in the 'Marketing and Promotion' section, the use of focus groups and pre-trial surveys are an effective data collection strategy to determine how interested community members are likely to be about a trial. Focus groups would be held with MIT staff and faculty that reside in the same town, city or zip code (for larger jurisdictions). Participants would be asked about their current commuting preferences, why they choose the mode(s) that they do, if they had considered ridesharing in the past, what the major obstacles are for them specifically and what sorts of incentives they are likely to respond to favorably. To the degree possible, existing rideshare commuters should be asked to give a testimonial about their experience, what their reservations were and what value they have received from their rideshare arrangement. Most importantly, focus groups provide a way of seeing and meeting potential rideshare partners without having to make any substantial commitment. Research from the UK suggests that participants feel more comfortable sharing rides with someone that they have seen face-to-face, even if they have not formally met the person (UK Department for Transportation, 2004).

Pre-trial surveys could also be administered to get anonymous feedback. Some staff and faculty may not be able to make the focus groups, or may be unwilling to share their true feelings about sharing rides in front of others. As mentioned previously, the release of the 2010 Commuter Survey with additional rideshare questions may eliminate the need for an additional pre-trial survey.

### 8.7.3 Performance Measurement – During & After the Trial

After a rigorous analysis of data in the pre-implementation stages, consideration needs to be given to sources of data that can be used during the trial. It may be helpful to start with desired performance metrics and think through how they can be measured. For an MIT community trial, recommended metrics would include:

(1) Number of Rides Offered (Driver)
(2) Number of Rides Requested (Passenger)
(3) Number of Successful Matches
(4) Number of Completed Trips
(5) Number of SOV Trips Reduced
(6) VMT Savings / Emissions Reductions
(7) Incentive Preferences (by Type of Commuter)
(8) Comparison of Pre-Trial / During Trial / Post-Trial Mode Choice
(9) Breakdown of Expenditures

Data on metrics (1) through (4), (6) and (7) would be gathered through the service provider's system. The information would be a combination of information selected by participants (such as incentive choices), gathered automatically by the smart phone (such as the confirmation that a trip is underway), and calculated in the service provider's software package (such as calculated VMT and emissions savings). Additional information from the MIT iParc parking management system could be used to verify that rideshare drivers parked during the day, but that rideshare passengers did not. Emission reductions would not be directly measured from the system; they would be calculated based on the VMT savings.
Metric (5) would need to use a combination of service provider data and information on past mode choice, such as is provided in the Commuter Survey. Participants would be given an SOV trip reduction index value, based on their previous mode choice. For example, those participants that previously drove alone five days a week would be given an index value of 1.0; for every rideshare trip, they have eliminated 1.0 SOV trip. For those participants that previously drove alone twice a week and used transit three days a week, an index value of 0.4 would be applied.

Metric (8) is the one that requires the largest amount of additional data gathering. Pre-trial mode choice would be determined using data from the Commuter Survey. For those that would like to participate but did not complete the most recent survey, a quick pre-trial survey could be administered. Ideally, the upcoming 2010 Commuter Survey will include a number rideshare specific questions, in addition to the weekly mode choice data. If trial eligibility were limited to only those participants that completed the 2010 survey, there would be no need for any supplementary data gathering. Weekly commuting trip surveys would need to be given during the trial and at several points after the trial had been completed to determine changes in mode choice.

Metric (9) would be a typical management responsibility. The total cost of the trial would be important to know, but the breakdown would provide some sense of what the most costly aspects of a rideshare initiative are.

### 8.7.4 Post Completion Surveys

Post-completion surveys would ideally be administered at multiple points after the completion of the trial to measure how behavior changed with the use of personal marketing and incentives, and possibly how it changes again after those benefits are removed. The major assumption in the use of post-completion surveys is that the trial is officially ended. If the results were sufficiently successful that participants request that the service remain in place, and the Institute administration decides to make it a permanent commuting service to all community members, there would be little ability to measure the degree to which commuters revert back to their previous choice of mode(s). If the trial is extended, post-completion surveys could be eliminated and commuting behavior would be measured using the biennial Commuter Survey.

## 8.8 Expanding the Trial to Other Organizations in Cambridge, MA

Ultimately, if the trial is successful at encouraging increased rideshare participation at MIT, consideration could be given to expanding it to other organizations in the Kendall Square/MIT area of Cambridge, MA. The Kendall Square area has a number of large firms, many affiliated with MIT that hire MIT graduates. Given the importance of common links between rideshare participants, including some of these local firms may be possible without introducing substantial safety concerns. From the perspective of MIT community members, including other firms may increase the number of potential rideshare options that exist. For the other Cambridge firms, the collaboration almost certainly increases the viability of ridesharing for their organization.

In much the same way that the trial has been designed for MIT, other organizations should consider a number of things before agreeing to a combined trial, including the viability of ridesharing within their own organization, whether their parking policies encourage non-SOV travel (whether it be ridesharing or transit) and how they provide transportation information to their employees. An initial travel survey is almost essential if one is attempting to determine rideshare viability. While an organization's parking does not need to be based on daily charges, this provides a wider range of options for encouraging behavior change.

From MIT's perspective, the integration would require some additional thought. As discussed, the selection of a provider with an open API would certainly make the technological aspects of the integration much simpler. Additionally, if safety is perceived to be a more important issue, additional features could be included to entice inter-institutional rides. From a technical standpoint, a participant rating system or possibly even a driver certification feature could be introduced into the existing service. Convincing existing participants that this is worthwhile may be more challenging. However, as with the design and implementation of the initial trial at MIT, the largest challenges are likely to be economic and institutional, not technical.

## 8.9 Summarizing the Case for a Technology-enabled Trial

MIT is an ideal place to demonstrate the potential of technology-enabled ridesharing. In the coming 12-18 months, a variety of factors both internal and external to the Institute will encourage community members to re-think how they travel. Potential changes in parking and transit policy within the Institute, the increasing prevalence of real-time transit information and the reconstruction of a major nearby transportation facility will all impact travel to and from campus. The provision of improved rideshare options could be an important alternative mode of transportation that the Institute could promote to its members. The potential benefits of a trial on the MIT campus should not be understated; other stakeholders are also beneficiaries of increased ridesharing. If designed appropriately, the provider of rideshare services, the MBTA and the City of Cambridge are all potential beneficiaries.

Past technology-enabled trials have had mixed results, but for the few that have been comprehensive and well designed the results have been encouraging. Strong institutional support and a commitment to devote the needed resources to marketing and incentives have been critical.

A comprehensive trial such as the one presented here can be cost effective for the Institute. The estimated cost for the construction and operation of a single underground parking space has been estimated at $7,500 per year (Block-Schachter, 2009). By comparison, the provision of rideshare services is estimated to cost $1,500 per participant in the initial year (assuming ~500 participants), with half of the initial costs in successive years. Table 8.4 provides a very rough “high end” cost estimate of the proposed rideshare trial. Outside sources such as smart phone providers, potential transportation research sponsors or public agencies may be able to absorb some of these initial costs.

**Figure 8.4: Rough “High End” Estimate of Rideshare Trial Costs**

| **Rough Estimate of Rideshare Trial Costs** | |
|---|---|
| Provision of Smart Phones & Monthly Subsidy | $300,000 |
| "Real-Time" Rideshare Service | $100,000 |
| Incentives | $100,000 |
| Multi-Modal Data Integration Feature | $50,000 |
| Management & Oversight | $100,000 |
| Marketing & Promotion | $50,000 |
| Miscellaneous | $50,000 |
| **Estimated Total** | **$750,000** |

The proposed trial is comprehensive and addresses a variety of the challenges facing ridesharing. It suggests that the use of advanced technology is necessary for the effective provision of rideshare services, but that it is not sufficient on its own. Ultimately, if rideshare participation is to be substantially increased at MIT, the use of technology combined with a personalized marketing campaign and the provision of incentives will be needed.

# Chapter 9: Findings and Recommendations

## 9.1 Research Findings

In his book titled "Paratransit in America", Robert Cervero remarked that,

> "The challenge in implementing smart paratransit [technology-enabled shared transport] has more to do with institutions, politics, and money than with technology. Applicable technology is already in place to launch successful smart paratransit…what is missing is an effective integration of individual "ideas" into a workable system, along with a conducive institutional, political and economic environment". (Cervero, 1997)

Cervero's remark is as relevant a description of technology-enabled ridesharing now as it was when his book was published thirteen years ago. Today's technology certainly enhances the ability to provide rideshare services and any minor shortcomings or technological challenges are few and are not substantially limiting participation. Institutional action, economics, and behavioral obstacles remain the largest inhibitors of increased participation.

The historical review of ridesharing demonstrated that periods of greater interest and participation have tended to occur when oil availability has been constrained, or during periods of economic hardship. By and large, ridesharing has had its greatest success when household budgets have been constrained, or when there has been a compelling national emergency. Motivations reported by individual rideshare participants also suggest that cost savings are a major motivation for sharing rides, both in the US and overseas. These findings highlight a particular challenge for policy makers to think of creative ways to encourage ridesharing that does not rely on decreasing financial freedom. Further review of a number of rideshare trials, where participation has been actively encouraged, has highlighted a mix of successes and failures. In those trials that were reasonably successful, significant marketing and promotion were undertaken and a large employer was the focus of the rideshare initiatives.

There are a variety of challenges that inhibit greater rideshare participation. The economic challenges with ridesharing have less to do with explicit attempts to curtail participation, and more to do with economic circumstances that promote vehicle ownership, yet provide little incentive to increase vehicle occupancy. The social and behavioral challenges are varied. Some concerns relate to the service itself, such as the perceived lack of reliability and schedule flexibility. Other behavioral challenges relate to the power dynamics between drivers and passengers, and concerns related to sharing a ride with a stranger. Institutional challenges are perhaps some of the most difficult to address. Appropriate roles for the public and private sectors have proven to be difficult to agree on, leading to tension between these two groups of stakeholders. The selection of a business model has also been a challenge for many of the private providers, due in part to different views on what an appropriate scale is for targeted rideshare initiatives. The technological challenges facing greater rideshare participation are minor in comparison to the economic, behavioral and institutional challenges. The accurate measurement of successful rideshare trips is the largest remaining technological challenge that can likely be overcome using new technology.

An innovative service known as “real-time” ridesharing has begun to expand the range of ways that travelers can share rides. It shows particular promise at reducing some market frictions associated with ridesharing, namely increasing schedule flexibility for participants and reducing transaction costs (such as the amount of effort needed to post one’s desire to share a ride). Unfortunately, the lack of reliability in this type of rideshare arrangement is such that it is unlikely to appeal to many commuters, as the likelihood of finding a match on short notice on a daily basis is relatively low. “Real-time” services are a necessary and welcome innovation in rideshare provision, but they do not address enough of the major challenges inhibiting ridesharing to induce substantial shifts in mode choice. If a single modification could be made to “real-time” services that would render them more useful, it would be a ‘timed-match’ feature that allows for confirmation of a ride match at a fixed time each evening before a morning commuting trip, and/or several hours before an afternoon commuting trip. If “real-time” ridesharing is to be successful, it will need to be paired with other rideshare service improvements.

With much of the research highlighting the importance of large employers, a feasibility study of ridesharing’s potential was undertaken for two large institutions, the Massachusetts Institute of Technology and the VOLPE Transportation Center. Using detailed travel survey data including the residential location of employees and typical arrival and departure times, the number of employees that could reasonably share rides with others within their organization was calculated. For current SOV commuters at MIT, approximately 78% of staff and faculty could be matched, with 67% capable of sharing rides on any given day. If those staff and faculty members where ridesharing is feasible all decided to share rides on a given day, it would result in a 19% reduction in Institute-wide VMT. Similar results were observed for the VOLPE Center staff; 71% of SOV commuters could be matched, with ridesharing possible among 62% of commuters on a given day. If all employees where ridesharing is feasible decided to share rides on a given day, VMT would be reduced by 6%.

With reasonably high rideshare potential at MIT and VOLPE, a technology-enabled trial was proposed for staff and faculty at MIT, with the express goal of expanding the trial to other institutions in the MIT/Kendall Square area of Cambridge, MA in the future. The results from a review of previous trials in chapter 3 presented a rather wide range of results, with some trials doing quite well and others doing rather poorly. It became clear that those trials that took a comprehensive approach to marketing, promotion and incentives, and focused on a large employer were the ones that had the greatest success. Those that performed poorly often neglected marketing and promotion. The proposed trial design provides an excellent opportunity to demonstrate that a comprehensive rideshare approach (one that considers individual motivations and needs, provides incentives, and uses existing technologies) can achieve substantial increases in rideshare participation, while requiring only modest levels of investment.

## 9.2 Promising Approaches and Stakeholder Specific Recommendations

The review of past and present rideshare initiatives has highlighted a number of approaches to increasing rideshare participation. Several of the most important approaches are discussed. Recommendations for individual stakeholder groups are also outlined.

### 9.2.1 Focus on Large Employers

Large employers should be the primary focus of rideshare initiatives. They have a much stronger ability to encourage alternative travel behavior among their employees, largely due to the variety of incentives and disincentives at their disposal. A modification in parking pricing tends to be the strongest disincentive to drive alone, and incentives such as reduced pricing for rideshare parking, preferential rideshare parking, pre-tax transit benefits and cash awards all help encourage shared vehicle use. Large employers also have the ability to survey their employees and gather important information on current travel behavior in much more detail than a private provider or public agency is typically capable of. This allows for much more detailed travel recommendations. While focusing on large employers narrows the size of the target audience as compared to targeting the general public, the likelihood of encouraging successful rides between employees is much higher. As compared to other stakeholder groups, large employers have many more tools at their disposal for encouraging better travel behavior.

### 9.2.2 Understand Individual Motivations and Undertake Personalized Marketing Efforts

Travelers are not a homogenous group. Some may be willing to share rides, but simply do not know where to find appropriate partners. Others may be willing to share rides if the incentives to do so are sufficiently high. Others may not be willing to share rides, but might consider park-and-ride opportunities if transit benefits were provided. Some subset of travelers is very likely to never share a ride because of personal preferences. Understanding these individual motivations can be time consuming and often requires large amounts of personal data, leading to privacy concerns. However the benefits can be substantial. Personalized marketing and travel planning that responds to individual motivations is more likely to result in changes in travel behavior. While the subset of individuals targeted is likely to be relatively small, the potential change in behavior is higher, as resources are only being directed at those travelers who are most likely to change their behavior.

### 9.2.3 Application of Technology Complements Other Rideshare Service Improvements

The use of “real-time” rideshare technologies can complement other changes in rideshare service provision, but should not be viewed as a sufficient solution to rideshare challenges. Smart phone technologies can be very useful at identifying non-recurring “immediate match” rideshare trips, displaying real-time information on other alternative modes of transportation such as public transit, measuring successful rideshare trips, and at incorporating additional safety features into rideshare services. However, it does not substantially address the economic and institutional challenges facing ridesharing. If participation is to be increased, the focus of future efforts should be on improving institutional collaboration and the economics of ridesharing, while incorporating the real advantages that new mobile technologies provide in a well designed a focused ridesharing initiative.

### 9.2.4 Recommendations for Large Employers

Large employers considering improved ridesharing options for their organizations should consider a number of important points when choosing a given strategy.

Surveys of employee travel behavior, particularly when they include travel behavior over a period of a week or more, provide a tremendous amount of information for evaluating the potential of ridesharing and alternative commuting modes. This information is relatively easy to gather and low cost in most cases, although privacy concerns will need to be considered.

Travel surveys allow for a much greater understanding of personal travel decisions and may allow for much more customized incentive packages for commuters. Detailed travel information can also allow for the identification of commuters who are very unlikely to change their travel behavior, and those individuals can be avoided. The resources that would have gone to more general marketing and promotion can be focused on those who are most likely to change their behavior. Personalized marketing, customized incentives and personal travel counseling provide excellent opportunities to improve commuter decision making and encourage alternatives to SOV travel. However, marketing and incentives are likely to be the single largest cost item for a rideshare initiative, so it is imperative that a strong institutional commitment be developed at the outset so that an initiative has sufficient time to demonstrate results.

Performance measurement is a key feature that should be included in all rideshare initiatives. The measurement of shared rides, commuter incentive preferences and long-term changes in travel behavior are all important metrics. With this information, the relative cost effectiveness of rideshare initiatives can be demonstrated and the results, if positive, can be used to support rideshare initiatives elsewhere.

### 9.2.5 Recommendations for Private Providers

Private providers will continue to have a strong role to play in the provision of rideshare software and matching technologies. While various business models have been attempted in the past, the targeting of large employers and regional/statewide public sector agencies appears to have the greatest lasting potential from a revenue generation perspective, and from a rideshare participation perspective. Past attempts to target the general public have been largely unsuccessful and should be avoided.

For those providers offering ‘real-time’ services, poor commuter perceptions of travel reliability remains a major concern. Slight modifications to ‘real-time’ services that would allow for confirmation of shared rides the evening before the morning commute, and several hours before the afternoon commute would provide some balance between the schedule flexibility and travel reliability that commuters seek.

For those providers that do not currently offer 'real-time' services on smart phones, increased use of technology may still be beneficial. The use of rideshare services on GPS-enabled smart phones allows for the provision of real-time information on alternative travel options such as transit, accurate tracking of rideshare trips and the incorporation of safety features.

### 9.2.6 Recommendations for Public Sector Providers

The public sector has various important roles to play in the success of ridesharing. While the provision of regional or statewide ride matching services is one potential role for the public sector, this is certainly not the most critical.

Public sector providers have a strong role to play in encouraging large employers to promote commuting alternatives to their employees. This can be accomplished through the use of 'sticks' and 'carrots'. Examples of effective 'sticks' that have been used previously have included Washington State's Commute Trip Reduction ordinance, which requires large employers to reduce vehicle trips, or the City of Cambridge, MA ceiling on parking spaces at MIT and other nearby employers. But the public sector is an important provider of 'carrots' as well. The provision of technical assistance to large employers in the development of ridesharing (or 'commuting alternative') initiatives and the funding of comprehensive demonstration projects would appear to be suitable roles for the public sector.

The public sector is also an important stakeholder in the evaluation of the effectiveness of different incentives. Public agencies have generally had a long history of providing incentives for rideshare initiatives and have sufficient resources to conduct participant surveys to determine which types of incentives are the most appealing to travelers and the most effective at modifying behavior. However, this is not to say that public sector providers should be the only stakeholder groups that evaluate incentive effectiveness; some private sector providers are equally well positioned to accomplish this.

## 9.3 Future Research

There remain a number of rideshare-related topics that are suitable for further research. It is worth emphasizing that many of these future research topics can be explored through properly designed and managed rideshare trials or demonstration projects.

### 9.3.1 Behavioral Links between Ridesharing, Transit & SOV Travel

If there is some agreement that the mutual goal of transit provision and increased rideshare participation is to reduce single occupant vehicle trips, research into the relationship between these three modes of travel may be worthwhile. Specifically, behavioral research into how travelers choose and mentally rank their modal preferences would be particularly helpful. In the specific context of MIT, an integrated rideshare-transit trial that explores behavioral responses to (1) improved rideshare options, and (2) the MIT Mobility Pass, may provide some sense of behavior differences by geographic location within the Boston area.

### 9.3.2 Household Use of Automobiles

Many of the potential benefits from ridesharing (including cost savings, reduced fuel use and reduced emissions) assume that the passenger's vehicle is not used during the day. There is some indication from past research that rideshare passengers share rides specifically so that other household members may use their vehicle for other purposes. The degree to which this occurs needs to be better understood. While the NHTS does track household travel behavior nationwide, it only does so for a single, 24-hour period. In order to determine how vehicle use changes when a vehicle is left at home, multiple days of travel data are needed. Once again, a smaller scale evaluation of complete household vehicle use could be incorporated into an MIT / Cambridge, MA rideshare trial though the completion of household travel diaries. If ridesharing is to continue to be branded a sustainable mode of transportation, further clarification of its potential to reduce overall household VMT and emissions is necessary.

### 9.3.3 Behavioral Responses to Incentives & Determination of Incentive Effectiveness

While the provision of incentives for rideshare purposes is relatively widespread, and while the variety of incentive types offered has been rather substantial, there does not appear to be much recent research on the effectiveness of different types of incentives. Hwang & Giuliano (1990) provided some important initial research that could be updated with more recent findings. Since public sector providers have tended to offer a greater variety of incentives, they would be well suited to undertake this type of update. Additional research into the effectiveness of innovative incentive packages, and their ability to encourage greater rideshare participation would also be worthwhile. The 'risk seeking' incentive package developed by Prof. Prabhakar and offered to bus commuters in a trial in Bangalore, India could be applied in modified form to a rideshare trial. With little hope of correcting the ingrained economic and political biases towards auto ownership and SOV travel, the provision of incentives for rideshare participation must continue to be considered an important second-best strategy.

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# Appendix I: Interview List

Mr. Carl Gorringe, Consultant to 511.org Rideshare, San Francisco Bay Area, February 24th, 2009

Mr. Sean O'Sullivan, Avego Shared Transport, February 12th, 2009

Mr. Steffen Frost, Carticipate, February 4th, 2009

Mr. Nicholas Ramfos, Commuter Connections, Washington, DC, January 30th, 2009

Ms. Robin Chase, GoLoco, January 16th, 2009

Mr. Charlie Crissman, Goose Networks, January 8th, 2009

Mr. Ali Clabburn, Liftshare UK, January 28th, 2009

Mr. Larry Brutti, Massachusetts Institute of Technology, April 17th, 2009

Ms. Kay Carson, MassRides, Massachusetts, February 3rd, 2009

Mr. Rick Steele, NuRide, January 16th, 2009

Mr. Eric Dewhirst, PickUpPal, February 2nd, 2009

Mr. Christophe Petit, Piggyback Mobile, February 18th, 2009

Ms. Cathy Blumenthal, RideshareOnline, Washington State, January 9th, 2009

Ms. Holly Parker, Yale University, April 17th, 2009

Mr. Logan Green, Zimride, January 27th, 2009

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