New Incentives to Change Modes: An Experimental Design to Reduce Single-Occupant Vehicle Commuting in Kendall Square

by

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Submitted to the Department of Civil and Environmental Engineering in partial fulfillment of the requirements for the degree of Master of Science in Transportation

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ABSTRACT

This thesis examines and suggests modifications to the design of employer commuter benefit programs to reduce single-occupancy vehicle commuting in areas served by transit with a focus on Kendall Square and MIT in Cambridge, Massachusetts. Sustainable transportation incentive programs for employers can be mutually beneficial for employees, employers, transit agencies, and cities if the options are offered in a manner that is simple to implement and maintain, flexible for employees, and cost little relative to the benefits provided to the employer. Employers are motivated to offer competitive benefits to attract employees while keeping their parking and overhead costs low. Cities wish to reduce road congestion and promote a business-friendly atmosphere in order to increase economic growth. Transit agencies (like the MBTA) want to increase revenue and expand ridership. Employees wish to spend less time and/or money commuting to work.

This research provides a baseline analysis of current commuting behavior for large employers in Cambridge, MA as well as an analysis of current Transportation Demand Management (TDM) techniques used nationwide and in Cambridge to provide incentives to promote behavior change. After examining the results of the previous employee MIT/MBTA Mobility Pass Pilot experiment, several implementation scenarios are proposed for an expanded experiment at MIT. The thesis provides the design for a tool to track the impacts of commuter benefit changes at the individual and employer level, as well as present a series of potential commuter benefits and their expected effects on mode share for large employers in an urban environment.

Using financial and social “nudges” to promote behavior change, the recommended incentives include an expanded universal transit pass, parking cash-out, daily parking charges, Walk or Bike to Work events, cash prize lotteries and a commuter dashboard with gamification elements to show employees their commuting behavior over time and keep them interested in alternative commutes over the long-run. By making transit, walking and bicycling the zero marginal cost choice while charging for parking and offering prizes for more sustainable commuting, employers, cities and individuals can reduce the demand for already limited parking spaces in an urban environment, live more sustainably, and reduce the need to build new parking infrastructure in the future. Federal law allows commuter benefits, including transit and bicycling, to be treated as ‘pre-tax,’ which provides significant financial incentive to support these initiatives.

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CHAPTER 1

1. **INTRODUCTION**

The goal of this research is to examine and suggest modifications to the design of employer commuter benefit programs to reduce single-occupancy vehicle commuting. Sustainable transportation incentive programs for employers can be mutually beneficial for employees, employers, transit agencies, and cities if the options are offered in a manner that is simple to implement and maintain, flexible for employees, and cost little relative to the benefits provided to the employer. Employers are motivated to offer competitive benefits to attract employees while keeping their overhead costs low. Transit agencies wish to increase revenues and ridership. Cities wish to reduce road congestion and promote a business-friendly atmosphere in order to increase economic growth. Employees wish to spend less time and/or money commuting to their jobs.

This research provides a baseline analysis of current commuting behavior for large employers in Cambridge, Massachusetts as well as an analysis of current technology used to provide incentives to promote behavior change. The thesis will present the design for a tool to track the impacts of commuter benefit changes at the individual and employer level, as well as present a series of potential commuter benefits and their expected effects on mode share for large employers in an urban environment.

1.1 **MOTIVATION**

In today’s political environment, major spending on infrastructure improvements has slowed dramatically throughout the United States. The focus of the US Department of Transportation (DOT) is on reducing roadway fatalities, improving air traffic control systems and reducing aviation accidents (US DOT, 2013). In the US DOT 2013 budget, $31.7 billion was allocated towards the national highway program, while only $10.7 billion was allocated to the Federal Transit Administration and $500 million allocated towards national infrastructure investments. The budget heavily favors automotive travel and projections for fiscal year 2018 show a similar pattern. Improving and building new roads through budgetary allocations makes commuting by car cheaper at the individual level. This leads to an increase in the number of people who live in the suburbs where they can afford housing and commuting in to the city for work. According to the 2009 National Household Travel Survey, commuting to or from work in America represents approximately 16% of all person-trips taken and 27.7% of all vehicle miles-traveled (NHTS, 2009). Between 2001 and 2009, overall time spent in a car as either a passenger or a driver decreased, suggesting that people are moving closer to the areas they want to travel to, or that they are traveling less often than they were previously (NHTS, 2009). Although not the largest proportion of trips taken, commuting trips can be affected by employer benefit policies, which makes them more easily influenced at the institutional level than social or
shopping trips. There are also likely more significant mid- to long-range impacts affecting vehicle ownership by household, and even home and job location choice. According to the Census Bureau, in the Boston metropolitan area, 67.3% of commuters drive alone to work (American Community Survey 5-year estimates, 2013). Over the last 30 years the percentage of commuters who carpool has decreased while the number of transit, bike, and walk commuters has increased.

As real estate prices in metropolitan areas increase, developers are motivated to build properties that will collect high rent on centrally-located parcels. With increased interest in urban workplaces, property developers must choose between building parking for tenants underground at high expense, an above ground garage that sacrifices viable commercial space, or providing a surface-level parking lot and sacrificing valuable vertical building space. At MIT, each underground parking space costs the university over $100,000 to build (Schmitt, Transport U: Colleges Save Millions By Embracing Policies to Reduce Driving, 2013). The developers pass on the costs of building parking to its tenants: employers. When developers pass on the costs of a limited parking supply to employers as part of building leases, they miss the auto accessibility for customers and visitors, and the market rate revenue they could be receiving from mid-day and evening visitors to retail establishments and offices. Employers interested in reducing their parking footprint due to rising costs, as well as addressing environmental concerns and promoting healthy commuting options for their employees would benefit from a formal review of their commuting benefits and an examination of the best incentives and disincentives for long-term behavior change.

Since 1973 parking in Cambridge, Massachusetts has been reported to the City and in 1998, Cambridge implemented a city-wide program to combat the rapid expansion of parking spaces within its boundaries. Any new non-residential development proposing the addition of more than five parking spaces must implement transportation demand management (TDM) measures to prevent increased single-occupancy vehicle (SOV) mode share as a result of the new parking spaces. This new policy resulted in employers setting goals for SOV mode share and reporting annually on the results of efforts to meet this mode share goal. However, some employers were grandfathered out of the program and are not required to participate in the annual surveys or report their commuting behavior to the City of Cambridge.

Massachusetts Institute of Technology (MIT) is one such employer who according to Federal air quality regulations must survey its employees biannually and report on employee commuting behavior, but does not participate in the Cambridge Parking and Transportation Demand Management (PTDM) program because its total parking supply was established prior to the ordinance. MIT is not required to report TDM measures to the city but they provide certain transportation benefits to their employees in the interest of employee satisfaction and retention, parking space costs and constraints on future institutional growth as well as environmental interests. MIT is currently participating in a pilot program that offers a select group of annual parkers access to free bus and subway transit on the MBTA in order to provide incentives to parkers to switch modes occasionally while continuing to allow access to parking facilities. The MBTA is supporting this experiment by charging MIT only for the transit rides actually taken by these auto commuters. This program, dubbed the “Mobility Pass” at MIT, can
be modified and expanded in order to be used as an incentive in the Kendall Square commuter study. MIT alongside selected other large employers in Kendall will be participating in this incentives study. Large employers control the largest proportion of commuters and therefore have the largest influence on a metropolitan area’s commuting mode share. Making changes to the benefits at large employers affects the most trips with the smallest managerial oversight, giving better return on investment in terms of experimental design and resources. Large employers also tend to set the trend in policies that are then adopted by small- and medium-sized employers.

Social psychology and behavioral science play major roles in this type of research. Research has found that when it comes to behavioral change, individuals are influenced by their peers and respond differently to different types of incentives. According to the psychological theory of motivation incentives, "people are pulled toward behaviors that offer positive incentives and pushed away from behaviors associated with negative incentives. In other words, differences in behavior from one person to another or from one situation to another can be traced to the incentives available and the value a person places on those incentives at the time." (Bernstein, 2011)

The transportation benefit recommendations in this thesis are based largely on historical experimental successes. Both positive incentives and negative disincentives are suggested based on studies in human motivation and previous work on commuter incentive programs. The marketing tools are designed to be intuitive and require as little input from employees as possible in order to promote tool usage and employee participation in the study. This research is a part of a larger project on changes to the pricing of commuter benefits taking place in Kendall Square, Cambridge, Massachusetts. The research included in this thesis will provide the experimental design and marketing strategy for an experiment to take place in the summer and fall of 2015. The results of the experiment will be analyzed in future works.

1.2 Objectives

The following are the specific objectives for this research:

- **Assess the current state of employer Transportation Demand Management (TDM) programs at the national, city, and employer levels**
  This thesis provides an in-depth analysis of national and local TDM measures in order to establish the state of the practice and use the results to inform TDM design for Kendall Square employers.

- **Determine the steps required to implementing an expanded Mobility Pass pilot.**
  Included in the thesis is an assessment of the steps required to implement an expanded pilot of the MIT/MBTA Mobility Pass. This portion of the thesis includes an introduction to the current Mobility Pass, a review of similar programs in other cities, proposed changes to the pass, potential challenges with implementation and recommendations for future steps as they relate to providing a universal transit pass for Boston area employees.
• **Determine the incentives that should be included in the experiment.**
  This thesis provides a list of potential incentives for employers to choose from when assembling their transportation benefit packages. An analysis of prior implementations (if available) of each type of incentive is also presented for review in order to allow employers to make informed decisions about which incentives may help reduce single-occupancy mode share rates the most based on the characteristics of their current commuting behavior and company characteristics.

• **Design a web-based tool to engage with employees, track participant progress, and deliver incentives.**
  The experiment requires a method for tracking the resulting changes to commuter behavior. Additionally, some of the incentives require a tool to communicate with employees participating in the experiment. Therefore, this thesis outlines a detailed design for a commuter dashboard tool. The dashboard will automatically capture the commutes of employees through transit, parking, walking and biking trips. This dashboard fulfills the requirement for providing a method of communication with study participants, and tracking the results of incentives on commuting behavior.

• **Analyze the current environment for technology as it relates to tracking commuting behavior.**
  This thesis provides a thorough summary of the mobile app and web-based software products currently on the market that provide journey-planning, carpooling, and individual commute tracking to employers and individuals. The research includes information on effectiveness of these tools when available and benefits and drawbacks to using each application.

1.3 **Research Approach**

The overall approach of this research is centered on the appropriate design and facilitation of an experiment to take place after the submission of this thesis. The research contained herein will provide a list of incentives to be included in the experiment, a detailed design of the experiment, and a design of its tracking tools. The tool design is based on the results of previous studies and input from the review of commercially-available products. An initial step is a review of current product offerings in the area of web-based and mobile applications used in transportation to work. Products are catalogued according to applicability, usefulness in commuting, robustness of the product’s company and positive design qualities. Next is a review of literature on motivation research in the fields of psychology and transportation. Following that is an investigation into existing transportation benefits and incentives which are analyzed for their effectiveness and ease of implementation.

A review of current employer transit pass program offerings by other transit agencies and recommendations for changes to the MIT/MBTA Mobility Pass universal program is also included as part of the research for this thesis.
Following appropriate software development standards, a design document for a web-based commuter dashboard is included as a part of research for this thesis. The dashboard shall include elements from commercially-available products and will utilize application program interface (API) definitions to recommend a product for development as a part of the FHWA study. The dashboard shall integrate feeds from the MBTA fare transaction data, the parking structures at employee sites, and mobile phone applications that track walk and bike commutes. It will also provide a platform for the gamification of commuting behaviors and allow an overall picture of individual's commuting patterns within and between Kendall Square employers.

1.4 Thesis Organization
This thesis is organized by chapter according to the objectives described in the above section. Preceding the first objective is a literature review of transportation incentive studies and studies focused on the psychology of human motivation, presented in Chapter 2. Chapter 3 contains an introduction to employer-based transportation demand management (TDM) programs at the national level and analyzes case studies from different cities and implementations. Chapter 4 includes an examination of the current TDM programs and policies in Cambridge, MIT, and Kendall Square. The chapter discusses the MIT/MBTA Mobility Pass pilot and provides recommendations for expansion of the pilot program to include more Kendall Square employers as well as modifying the program to work better for the MBTA and the participating employers. Chapter 5 contains a breakdown of proposed incentives for Kendall Square employers and provides an experimental methodology for implementation. Chapter 6 contains a design document for the commuter dashboard tool for use in the FHWA study. Finally, Chapter 7 summarizes the previous chapters and provides recommendations for future work on the topic of commuter benefits and incentives. Appendix A contains a table of current mobile and web-based applications for journey-planning, analyzing potential alternatives, and forming carpools.
2. LITERATURE REVIEW

Chapter 2 consists of a review of the current literature on behavioral economics and psychological principles as they relate to motivation and persuasion. The chapter also highlights studies on the short and long term durability of behavioral interventions, and applications of behavior change in the transportation field.

2.1 BEHAVIORAL ECONOMICS

At the intersection of psychology and economics is a field of study proposed by Herbert Simon in 1955 (Simon, 1955) and further defined by Kahneman and Tversky (D. Kahneman, 1979) known as behavioral economics. Simon proposed that the “rational man” of traditional economics does not always make the same economic choices those made based on human behavior. The researchers proposed that psychological principles should be applied to the study of economic decisions of individuals and institutions.

In a review of behavioral economics studies and their impact on the transportation sector, Robert Metcalfe from the University of Oxford and Paul Dolan from the London School of Economics provided a summary of the effects of incentives on behavior based on the work of Kahneman, Tversky, Camerer et al and DellaVigna. They found that in terms of incentives for behavioral change, people strongly dislike losses, overweigh the probability of infrequent events occurring, think in discrete monetary bundles, value the present more highly than the future, and can be negatively impacted by incentives (Metcalfe, 2012). In one study participants were asked to either to participate in a lottery incentive program or deposit money into an account and they would receive the money back with a bonus if they met their weight loss goals (Volpp, 2008). The study showed that the incentivized participants lost significantly more weight than those in a control group, and that the group who deposited funds in an account lost the most weight because they felt the largest pain from the loss of funds. This concept can be applied to transportation incentives offered to employees where groups participate in a challenge to reduce single-occupancy commutes and can receive different financial incentives for their participation.

People tend to overweigh the probability that low-chance events will occur. They do not ride on airplanes for fear of crashing, but the probability of this occurring is the same as being struck by lightning seven times (Golgowski, 2014). This fear of low probability events can affect mode choice if an individual is fearful of unsafe bicycling conditions, train accidents, or carpooling with a dangerous stranger. Dolan et al. found that people do not accurately assess their potential for injury, overestimating the costliness of an activity on their wellbeing (Dolan, 2008). Providing statistics on the safety of certain activities and framing the message such that people are likely to trust the
information may help assuage fears of low probability events when it comes to choosing from their commuting options.

Behavioral economics studies suggest that people think about their money in terms of discrete bundles. They mentally allocate funds to salary, rent, savings, and others and do not like to move funds between these different bundles (Thaler, Mental accounting matters, 1999). According to a 1985 study by Thaler, people are willing to go to extra effort to save $5 off of a $20 item, but not $5 off of a $200 item even though in both cases the absolute amount saved is the same (Thaler, Mental accounting and consumer choice, 1985). Discrete monetary bundles can used to the advantage of new commuter benefits design by emphasizing that gas, tolls, transit passes and parking costs should be considered a “commute cost” bundle. This bundle can possibly be reallocated from SOV commutes to different modes without increasing the amount of money or time that must be in the “commute cost” bundle.

The paper by Metcalfe and Dolan also states that people value the present very highly (Metcalfe, 2012). People prefer smaller amounts of money immediately to larger sums in the distant future. The researchers mention a study on the effects of presenting a reward immediately when treating substance abuse, and the results of the study show that the more immediate the reward and the larger the monetary value, the more substantial the change in behavior (Lussier, 2006). In a study focused on environmental conservation motivations, the authors suggest that “the more immediate and local the benefit, the more successful should be the outcome” through systems of conservation incentives (De Young, 1996). This can be applied to transportation benefits by offering financial incentives to take active and sustainable modes and to reward participants for the behavior immediately after they make their commuter mode choice.

Personality and preferences for different types of commutes are related. A study in Europe analyzing the interdependence of commuting decisions found that those commuters with pro-social leanings (i.e., those who wished to maximize collective outcomes) as well as high levels of trust and belief in the cooperative intentions of fellow commuters preferred public transportation over car commuting. These same commuters also had a reduced desire to avoid other commuters. However, those commuters with a pro-social orientation with low levels of trust or those primarily interested in maximizing their individual outcomes preferred car commutes over public transportation. The researchers found a positive correlation between car commuting and a desire to avoid other commuters (Joireman, Van Lange, Kuhlman, Van Vugt, & Shelley, 1997).

2.2 MINDSPACE

Originally proposed in Dolan et al. 2010, MINDSPACE is an acronym that represents the role of context on behavior changes. As seen the in the following table, MINDSPACE stands for Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitments, and Ego; the principles guiding influences on behavior. Each of these concepts can be applied to modifying commuter behavior.
MINDSPACE

**Messenger**  We are heavily influenced by who communicates information

**Incentives**  Our responses to incentives are shaped by mental shortcuts

**Norms**  We are strongly influenced by what others do

**Defaults**  We 'go with the flow' of pre-set options

**Salience**  Our attention is drawn to what is novel and seems relevant to us

**Priming**  Our acts are often influenced by unconscious cues

**Affect**  Our emotional associations can powerfully shape our actions

**Commitments**  We seek to be consistent with our public promises, and reciprocate acts

**Ego**  We act in ways that make us feel better about ourselves

*Note:* This is taken from (P. Dolan M. H., 2010) and (P. Dolan M. H., 2012).

To illustrate the power of a few of these concepts, Metcalfe and Dolan provided studies that used one or more of the MINDSPACE principles to influence behavior. In one study by Madrian and Shea, the researchers tested an employee 401(k) policy to determine that if the default for a group was to be automatically enrolled (opt-out), 86% of employees participated. If the default policy for the group is to require sign up for the 401(k) (opt-in), only 49% of employees participated (B. Madrian, 2001). This suggests that by modifying the default behavior, one can influence what the majority of participants will do.

Another concept is of saliency: the more acute the pain or joy, the stronger the feelings toward a particular activity. A study by Kahneman et al. showed that participant's memories were controlled by the most intense moments rather than the average experience, and that people remember the final impressions rather than those from the middle of an activity (Kahneman, 1993).

Priming is the act of exposing people to stimuli that then influence behavior such as priming a participant with words associated with cooperation that leads to people donating 40-50% more money than a control group not exposed to priming words (Drouvelis, 2010). Additionally, including priming pictures such as that of a smiling attractive person can increase demand for certain products as much as offering a monetary discount. This is considered “affect.” Negative affect, where participants are exposed to negative images associated to not performing a behavior, has a large effect on behavior change.

A study on commitments found that the act of writing a commitment increases the likelihood of performing the behavior included in the commitment (Cialdini, 2007). Similarly, simply asking people about their behavior and choices can make it more likely they will behave identically in the future; suggesting that merely studying the behavior can influence the behavior. In one study, researchers asked people about their intention to vote in an upcoming election and those who were asked were found more likely to vote in future elections (A.S. Gerber, 2003).
2.3 **INTRINSIC VS EXTRINSIC INCENTIVES**

In psychology, there are two types of incentives— intrinsic and extrinsic. Intrinsic incentives refer to performing activities that one is motivated to do naturally because they are inherently interesting (such as solving a puzzle), while extrinsic incentives are those that one does because one is provided incentives to do them (such as getting paid to wash a car). Studies in this area explore the relationship between money and motivation. For example, in a study by Deci et al., Deci brought two groups of participants into a room for three separate sessions. In the first session each group was given puzzles to solve for an hour without payment. In the second session, the treatment group was offered $1 for each puzzle solved while the control group was not. In the third session, the researchers reverted back to the first session scenario: no financial incentives were offered. Deci found that the previously-paid treatment group no longer worked as long on the puzzles in the third session as their intrinsic desire to solve puzzles had been replaced by an extrinsic monetary value associated to solving puzzles (Deci, 1971). According to a previous review of motivational incentives, “the main lesson from the psychology literature on intrinsic motivation is simply that it is a bad idea to temporarily pay people for an inherently interesting task; there is no systematic evidence from this literature that indicates long-term monetary incentives can backfire.” (Kamenica, 2012)

The use of monetary incentives in behavior modification studies may lead to the intrinsic desire being pushed out by the prospect of funds. According to Benabou and Tirole, once an activity has been associated with receiving an extrinsic reward, a participant will be less likely to perform the activity without the reward in the future. They argue that “incentives are then only weak reinforcers in the short run, and negative reinforcers in the long run.” (Benabou, 2003) In the 1996 Raymond De Young study of conservation motivations, Young found that social norms promoting conservation and structural changes to the environment (such as high-occupancy toll lanes or slow elevators) influence individual’s travel choices as extrinsic, non-monetary incentives to behavior change (De Young, 1996).

Although this research suggests that monetary incentives may de-motivate those participants who were previously choosing active and sustainable modes, providing small incentives for those who drive alone to work can lead to an intrinsic motivation to choose alternatives provided that the experimental design includes factors that help transition extrinsic incentives to intrinsic motivations.

In a comprehensive review of literature related to transitioning extrinsic motivations to intrinsic motivation to reduce consumption behavior, De Young found that emphasizing frugality and providing small rewards for frugal behavior motivated participants in many studies to continue the positive behavior after the rewards ceased. The same was true if participants felt they were contributing to something that would make a difference, and were persuaded that their participation in the activity was necessary to advance the cause, they would develop intrinsic motivation to continue the behavior after the completion of the study (De Young, 1996). This research suggests that there are ways of framing the experiment in transportation benefit changes for the participants such that the participants feel intrinsic motivation to continue to take alternative modes to work after the end of the experiment.

In a study on “Bike to Work” events, researchers found that the participants valued event features related to intangible benefits more than tangible ones. The figure below shows the riding to work
event features most valuable to participants: being a part of a big event and seeing lots of people biking. Significantly lower on the scale are prize draws (extrinsic motivation), which are valued by only 5% of participants in the study. This suggests that the improved social and societal aspects of alternative commuting modes should be emphasized over the financial incentives of participation.

![Graph: ROSE & MARFURT BICYCLE EVENT FEATURES](Rose & Marfurt, 2007)

In addition to measuring the effects of intrinsic versus extrinsic motivation, it is important to consider the long- and short-term changes to behavior, which can inform the design of an experiment whose purpose is long-term behavior change towards more sustainable commuting practices.

2.4 SHORT VS. LONG-TERM BEHAVIOR CHANGES

When proposing incentives for behavior modification researchers hope for lasting change, not just a single day of modified choices. The hope is that people do not revert back to their original habits after the period of study is over and the incentive has faded from memory. In April 2015 the MBTA hosted a free fare day for the city. Undoubtedly this type of event will increase ridership for the day it is in effect, but its long term effect on ridership is not as assured. According to Cervero, although fare-free days are a reasonable promotional tool, “researchers concluded that they were a poor way of capturing mass transit’s purported social benefits.” (Cervero, 1990) However, there are studies in psychology that show that there can be short- and long- term benefits to certain types of incentives.

A study on meditation and its effect on long-term positive emotions provides a good example of “durable interventions” that last longer than a simple financial transaction or one-time behavior change. Researchers performed a “meditation intervention,” then examined how many of the participants reported positive emotions and continued to practice meditation 15 months after the
initial intervention. Researchers found that all participants maintained the gains in positive emotions they had seen during the initial study period, even if they did not continue to meditate (Fredrickson, 2010). This study and the proceeding study suggest that long-term behavior change is possible using appropriate intervention design and conditions.

In a three year longitudinal study on household environmental choices, researchers were able to produce durable increases in pro-social, pro-environmental behaviors through the use of information, feedback, and social interaction (Staats, H., Harland, P. & Wilke, H. A., 2004). The researchers in the study examined 38 household behaviors such as leaving the tap on when brushing teeth or throwing away compostable waste. They then placed some members of the study on an EcoTeam and provided them with sustained information about how others on their team were behaving, the amount of each type of household behavior they were doing independently, and provided opportunities to socialize with other members of the team. The experiment studied the behavior of this group for three years and found that participants changed half of their household behaviors. This corresponded to similar reductions in resource use, included a 7% reduction in water consumption and a 32% reduction in solid waste in the trash two years after the end of the three year study. This study suggests that social interaction as well as feedback on individual performance and information on pro-social behavior may cause a lasting change in behavior for study participants.

2.5 BEHAVIOR MODIFICATION IN TRANSPORTATION

Behavioral economics has been applied to the transportation sector through a series of experiments that focus on behavior modification with the use of gamification, real-time information and incentives. The rise of the mobile app has led to advancements in all three areas where researchers can provide study participants with a place to track their progress in real time and compare their results with their peers. Below is a review of the literature on gamification and real-time information. For a review of studies on incentives, see Chapter 3.

2.5.1 GAMIFICATION

Gamification is defined as “the use of game design elements in non-game contexts” (Deterding, 2011) and includes competition among participants, the distribution of prizes or rewards, and elements of novelty and fun to maintain interest in the application. The following are summaries and results of studies performed in the area of transportation that include elements of gamification.

**Utah Clear the Air Challenge**

In 2008, the Utah Department of Transportation (UDOT) launched a TDM program to promote non-single-occupancy vehicle commutes. By promoting more active and sustainable strategies such as carpooling, flexible work hours, teleworking, transit, bicycling, walking and trip planning, Utah has measurably reduced its drive-alone trips during the period of the experiment. UDOT uses a self-reporting tracker that has organizations and individuals compete against each other to attain the most non-SOV trips (UDOT, 2015). The tracking application was developed by RideAmigos, a company with a short profile featured in Chapter 6 in reference to the design of the commuter dashboard. The
2014 Clear the Air Challenge recruited 6,876 participants, 94% of which joined the Challenge through an employer team. This suggests that the most effective means of recruiting participants for city- or state-wide programs is through employers rather than individuals. The program distributed 4,000 free UTA 7-day transit passes for use on the bus, light rail, and commuter rail as well as 250 carshare passes and 150 bikeshare passes within Salt Lake City. The application allowed you to see individual and team statistics to track your own behavior over time and also compare it to other participants within and between organizations to create competition and promote more sustainable commuting choices.

**CARPOOLING MATCHING IN BRAZIL**

In Brazil, researchers performed an exploratory study on the design of a web-based carpooling application that would introduce drivers to other members of their networks with similar commutes and asked how likely they would be to share rides based on a number of parameters. They included elements of gamification in their design such as including a scoring system, rewards for performance and a ranking system to score participants. Those polled were asked to choose which type of rewards would most motivate them to ride share between discounts on services, gifts, prestige, competition between friends, no reward or other. Those polled also responded that they would be most interested in using a ride sharing application that provides service discounts as a reward, however a high percentage of respondents stated that they would not be motivated to participate in ride sharing by any type of reward. The researchers came to the following conclusion: people are interested in sharing rides but they want to share rides with people they know already, not just people within their school or work network. Participants were concerned about security and privacy while ride sharing, but the researchers recommended displaying a user’s rating and their ride sharing activities on the site to help humanize users and suggest rising participation rates among users. (Vieira, 2012)

**SUSTAINABILITY AND CORPORATE RESPONSIBILITY GAME**

A company, Practically Green, developed a game to track and promote sustainable behaviors for individuals and companies based on the behavior design models of two psychology and economics researchers. Robert Cialdini, a professor of psychology and marketing at Arizona State University contributed the concepts of “social proof” and “liking” to the design. According to Cialdini’s work, “by making actions visible, the commitments people make helps bring visibility to everyday sustainability actions that may go unnoticed otherwise.” (Stevens, 2013) This visibility also helps develop and cement new social norms and provides positive feedback to those who participate in the program. B.J. Fogg of the Stanford Persuasive Technology Lab developed a Behavior Grid for measuring both short- and long- term effects of behavior change by defining certain activities as “Dot,” “Span,” and “Path” behaviors. A “dot” behavior would be a one-time behavior, such as purchasing a reusable grocery bag. A “span” behavior is a behavior that has a duration, such as taking the bus for a month. A “path” behavior is one that provides lasting change, such as selling the family car or installing solar panels (Stevens, 2013).

Users are invited to “like” activities, share accomplishments, and rewarded when they recruit others to join the game, providing long-term visibility and external incentives to continue to participate. Users are provided with points for various sustainable activities and can see where they rank compared to
those on their team or colleagues. Incentives come at the individual and group level and can be timed to allow "path" changes as well as "span" changes. For example, in one instance, employees participated in a "Ditch the Cup" initiative where anyone with a reusable cup got free coffee for the day. This initiative measured success based on the number of cups saved that day and the total participation in the event. A similar application to transportation could be made with Bike to Work days or other single events that temporarily reduce parking demand but may provide employees with the motivation to occasionally choose an alternative they had previously never considered.

2.5.2 Real-time Information
Real-time information provides users with more flexibility in their mode choice. They can view when the next bus or train will arrive, how many bicycles are available at the station nearby, and how far away the closest taxi or carpool is to their location in addition to how long each mode will take them to arrive to their destination. Not only useful in journey-planning, researchers from Georgia Tech found that waiting time decreased and ridership increased for those with access to real-time bus arrival information (Brakewood, C., Macfarlane, G., and Watkins, K., 2014).

New companies are forming every day to provide real-time updates on the number of steps a phone user walked in a day, the length of time they spent procrastinating on the internet instead of working, and the ability to form casual carpools just in time to make the rush hour HOV lane opening home. Access to real-time data is already changing the way people commute through Uber or Bridj or Ride (see Appendix A for a description of these companies). Real-time information can be utilized at the institutional level to determine how many parking spaces are available at any time of day in an employer parking garage and the number of casual carpoolers who need parking spaces for the day, in addition to measuring long-term trends in employee behavior such as arrival/departure rates from work.

This area of emerging technology should be considered in the development of mobile apps associated to commutes to work, transportation demand management strategies for the Kendall Square employers and the commuter dashboard.

2.6 Summary of Literature Review
This chapter describes previous research in behavioral economics, psychological methods of motivation, and an examination of short and long term behavior changes. Some key takeaways from this chapter are:

- Transition extrinsic motivations into intrinsic ones for more effective behavior change
- Experiments can be designed to promote durable behavior change using social gamification
- Follow the principles of MINDSPACE when developing a behavior change experiment
The chapter ends with applications of the principles in transportation in the form of gamification and real-time information. Chapter 3 contains a summary of employer Transportation Demand Management (TDM) and case studies of TDM program implementations in other cities.
CHAPTER 3

3. NATIONAL EMPLOYER TDM PROGRAMS

This chapter introduces employer transportation demand management (TDM) and potential incentives and disincentives for behavior change in the field of TDM. The chapter then provides case studies of the effectiveness, benefits, and potential issues of various TDM incentives in other cities across the United States.

3.1 HISTORY OF EMPLOYER TRANSPORTATION DEMAND MANAGEMENT

Most recently written into law as a part of the 1990 amendments to the 1970 Clean Air Act, the initial focus of employer TDM was to increase the occupancy of vehicles by promoting carpools, vanpools and public transportation. Established by federal law in 1993, commuting pre-tax benefits were introduced to allow employers to offer programs that encouraged mass transit commutes by treating transportation costs as pre-tax expenses. This saves employers money by reducing the amount of taxable income and social security tax payments that must be paid, while also reducing the income tax burden on employees. This law incentivized further investment in employer transit benefits and motivated transit agencies to offer programs that would increase ridership and revenue offered specifically to employers.

According to a recent report on effective TDM measures, “managing demand in the 21st century is about providing travelers, regardless of whether they drive alone, with travel choices, such as work location, route, time of travel, and mode.” (Schreffler, 2010) This perspective is a change from traditional demand management, which focused on a shift to higher-occupancy modes as opposed to promoting alternatives such as bicycling or walking in addition to transit and carpooling. In Europe, many countries have recognized the need to combine technological and behavioral change initiatives together in order to be most effective at reducing the demand for SOV commutes. Research has shown that while it is relatively easy to implement the technology associated with TDM, it is more challenging to develop a coordinated TDM effort that includes behavioral change methods, technology, and active mode infrastructure in order to ensure the most effective TDM implementation (Schreffler, 2010).

The current practice of TDM recognizes that managing demand for travel is of higher importance than increasing the occupancy of vehicles already on the road. Experts recommend managing this demand by expanding the supply of more sustainable travel alternatives, providing incentives and rewards for using sustainable modes, and passing along the full cost of using a car to its users (Schreffler, 2010). Passing along the full cost of car use, however, conflicts with the concept of transportation benefits for employees, which for the majority of Americans is on-site parking.
The theory behind parking’s role as a societal benefit has evolved over time. During the highway era, the government was expected to provide parking as a key piece of infrastructure, which led to the development of parking alongside every city street. There was backlash from the community if businesses and properties did not provide on-site parking for their customers and residents, which led to the advent of parking minimums as part of zoning requirements. Beginning in the mid-1990s with Donald Shoup, who performed studies on the impacts of excess parking on development, and others, the new approach is to impose parking maximums in urban areas to promote densification of residences and businesses. Parking maximums reduce the number of excess parking spaces and promote alternative modes of travel including public transit, walking and bicycling.

3.2 TRENDS IN TDM NATIONWIDE
Since the oil crisis of the early 1970s, communities across the U.S. have increased their interest in reducing SOV commuting and a large part of that is due to legislation and employer benefit changes. Transit benefits offered by employers are not a new concept in many parts of the nation, and in Boston the MBTA was one of the first to offer a corporate pass program. Local municipalities such as Arlington County, Virginia have dedicated staff to research TDM opportunities and promote alternative commutes to employers. They have influenced travel policy such that while Arlington grew 38% in population and brought 35% more jobs to the area between 1980 and 2013, they did not increase road infrastructure or vehicular traffic during that same time period (VTPI, 2015).

"There is a growing realization that the dysfunction caused by poorly conceived parking policies is a major impediment to creating an effective and balanced urban transportation system, it is also a significant cause of traffic and air pollution." – ITDP Report on U.S. Parking Policies (Weinberger, Kaehny, & Rufo, 2010)

Employers in the U.S. began to invest in TDM programs when they determined that they could save on parking and road infrastructure by reducing the demand for drive alone commuting. With strong backing from local transit agencies providing corporate programs, large companies like Nike offer its employees “Nike Bucks” for non-SOV commutes as well as heavily subsidized transit passes, which has led to a 15% reduction in the number of employees who drive to work (Transportation Demand Management Institute, 1997). In July of 2014, a report by the ITDP stated as one of its objectives towards improved parking policy in the U.S. was to “promote parking and commuter programs that expand travel choices for employees and customers” (Weinberger, Kaehny, & Rufo, 2010). The goals have shifted from worrying about expanding supply, to reducing demand for parking spaces.

3.3 INCENTIVES AND DISINCENTIVES FOR CHANGING MODE CHOICE
This section contains an introduction to various potential TDM incentives and disincentives for reducing single-occupant vehicle mode share in commuting. Each incentive has a discussion of the costs and benefits associated to its implementation, as well as case studies outlining their effects on mode choice. Donald Shoup’s perspective on incentives for mode choice is reflective of the
importance of providing good reasons to change: “People like incentives more than penalties, that’s why restaurants give early-bird discounts rather than, say, increase prices at 6 pm.” (Farivar, 2012)

Much like giving restaurant patrons discounts for desired behavior, commuting behavior can be modified to increase the percentage of people who carpool, take public transit, walk or bicycle to work. This can be accomplished through financial prizes, universal passes, parking cash-out, bikeshare/carshare subsidies, and others.

According to a 2014 Virginia Tech study, offering commuter benefits that provide incentives to active and sustainable modes and dis-incentivize free parking for single-occupancy vehicles lead to the largest changes in mode share (Hamre & Buehler, 2014). The researchers performed a multinomial logistic regression to show that free car parking is positively associated with higher SOV mode share. They found that commuters who are offered transit benefits, showers/lockers, and bike parking in combination with parking fees were the most likely to reduce automobile commuting behavior.

3.3.1. INCENTIVES

This section highlights the variety of incentives that can be provided to employers to promote non-SOV commuting. It includes a discussion and case studies on universal passes, parking cash-out, “bike to work” and short term initiatives, bikeshare/carshare subsidies, carpool matching, and financial (lottery) incentives. Employees may respond differently to incentives based on how far away they live from their employer and mode splits to some extent are distance-based. Figure 3-1 shows the extent of the reach of modes based on distance from downtown Boston with car and vanpools dominating the mode split beyond ten miles outside the city and bicycling available only within five miles of downtown. There are those outlier commuters who bicycle over five miles to work each day, but for the most part, this figure represents the mainstream approach to commuting.

![FIGURE 3-1: DOMINANT MODES BASED ON MILES FROM DOWNTOWN BOSTON](image)
UNIVERSAL PASSES

A universal transit pass is a program that gives a set of people in an organization unlimited access to local transit (trains and buses) for a fee paid for either by the individual or the group. Provided to students of a university or employees of a firm, universal passes can be offered as a commuting benefit to members of organizations and used to reduce single-occupancy vehicle commuting, or to increase off-peak usage of the transit system by students. Universal transit passes are the result of an agreement between the transit agency and an organization, and can benefit both the organization and the agency under certain conditions.

In 2005, the Federal Transit Administration sponsored a report that analyzed the effectiveness of transit agencies offering commuter benefits programs. The report was published by the Transportation Research Board as part of the Transit Cooperative Research Program (TCRP). The study examined the most effective commuter benefits programs in the US and included recommendations related to universal access passes.

Some transit agencies featured in the report were concerned about a loss of revenue that may come with providing discounted fares to those who might have paid the full amount. However, the conclusions of the study suggest that providing employers with greater pricing flexibility attracts more participants in the universal pass program, citing university program’s successes in ridership and reduction in single occupancy vehicle usage (ICF Consulting, 2005). Employer subsidies are a strategic opportunity for transit agencies to increase their revenues. Employers who pay a fixed price per transit pass for participating employees usually pay more for fares than the employees use the system. In the transit agencies surveyed, although they were offering discounted fares for universal passes, their ridership continued to increase and this surpassed the revenue they would have received based on the original number of system riders. The report found that “up to 35 percent of transit benefits recipients reported increasing their use of transit; this includes both previous riders who increased their frequency of use as well as new riders.” (ICF Consulting, 2005, p. 49)

Agencies were also concerned that ridership could not rise because they reasoned that all users who would be willing to ride were already riding the system because they were operating in a high-transit metropolitan area. They found, however, that “even in very transit-intensive areas, new riders can still be added.” (ICF Consulting, 2005, p. 48) This bodes well for the MBTA in Boston, who may benefit from increased ridership even under peak capacity constraints. The report determined that most of the new ridership was the result of commuters switching from single-occupancy vehicles. In over half of the surveys sent to transit agencies, 90% of the new riders switched from driving alone. This switch can help cities reduce parking demand and pollution. (ICF Consulting, 2005, p. 4) Companies that relocate within the Boston area can use their new location as an opportunity to change their transportation benefits and policies to improve their transit mode share by engaging with the MBTA.

Many agencies in cities nationwide offer discounted and unlimited passes to employers in order to increase transit ridership and incentivize commuters to switch from SOV trips. Valley Metro in Phoenix has a Platinum Pass program that employers can offer to their employees where all employers with more than 50 employees are required to participate due to a trip reduction program mandated by
the county. The Platinum Pass is “pay-per-ride” up to a maximum of $104 per month per employee. Denver’s Ecopass program, on the other hand, is most similar to Seattle’s ORCA Business Passport where card holders have unlimited access to bus and light rail and the employer pays the agency based on the size of the employee base and location in the network.

TABLE 3-1: TRANSIT MODE SHARES FOR THE SIX LARGEST EMPLOYERS PARTICIPATING IN METROPASS IN THE MINNEAPOLIS/ST. PAUL AREA

<table>
<thead>
<tr>
<th>Number of Employees</th>
<th>Transit Mode Share</th>
<th>Increase in Transit Riders per 100 Employees</th>
<th>Increase in Transit Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>5,535</td>
<td>56.2%</td>
<td>68.0%</td>
<td>11.8</td>
</tr>
<tr>
<td>2,712</td>
<td>30.0%</td>
<td>32.0%</td>
<td>2</td>
</tr>
<tr>
<td>14,123</td>
<td>10.6%</td>
<td>10.0%</td>
<td>-0.6</td>
</tr>
<tr>
<td>4,942</td>
<td>7.7%</td>
<td>8.0%</td>
<td>0.3</td>
</tr>
<tr>
<td>5,382</td>
<td>6.8%</td>
<td>7.0%</td>
<td>0.2</td>
</tr>
<tr>
<td>4,815</td>
<td>4.0%</td>
<td>4.0%</td>
<td>0</td>
</tr>
</tbody>
</table>

(ICF Consulting, 2005, p. 46)

In Minneapolis, introducing the MetroPass provided by Metro Transit resulted in a change in transit ridership and mode share to the six largest employers seen the table above. As you can see, the universal pass increased transit mode share in four out of the six largest employers. Among the larger employers, the companies in Minneapolis with the largest prior transit mode share saw the largest increase in transit ridership after implementing the transit benefits program. For more on Minneapolis, see the case study on Minneapolis later in this chapter. This suggests that if a similar pass were to be introduced in Boston that the companies with the largest transit mode share before the pass would see the largest increase in transit ridership after its implementation. These programs have all had a positive influence on transit ridership. Combining the best aspects of each pass design will ensure that Boston has an economically and socially beneficial universal pass option.

CASE STUDY: PORTLAND EMPLOYER PASSES

INTRODUCTION

Portland’s TriMet agency uses a pay-per-ride system for its universal pass implementation: employers must provide passes to all eligible employees and are charged only for actual use. Employees have a sticker on their ID badge and usage is determined based on a commuting survey distributed to all employees.
Results of the Past 15 Years

Employers in Portland offer a wide variety of transportation benefits to their employees ranging from access to a variety of TriMet passes, to pre-tax transit benefits, subsidized passes, bike lockers, showers, telecommuting and compressed work week options. TriMet implemented their employer pass program in 1998 and they have seen significant increases in ridership, employer participation and revenue over the past 15 years. The introduction of the universal pass has significantly affected mode share for the companies that offer it as seen in the table below.

<table>
<thead>
<tr>
<th>TABLE 3-2: UNIVERSAL PASS PROGRAM COMMUTE MODE SPLITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Alone</td>
</tr>
<tr>
<td>1998</td>
</tr>
<tr>
<td>77%</td>
</tr>
<tr>
<td>Rideshare</td>
</tr>
<tr>
<td>10%</td>
</tr>
<tr>
<td>Transit</td>
</tr>
<tr>
<td>8%</td>
</tr>
<tr>
<td>Bike</td>
</tr>
<tr>
<td>1%</td>
</tr>
<tr>
<td>Walk</td>
</tr>
<tr>
<td>1%</td>
</tr>
<tr>
<td>Telecommute</td>
</tr>
<tr>
<td>0%</td>
</tr>
<tr>
<td>Compressed Work Week</td>
</tr>
<tr>
<td>1%</td>
</tr>
</tbody>
</table>

Universal passes contribute to more flexible commuting options, allowing for increased public transportation options, supplemented by bike and walk commutes. For those companies that offer the pay-per-use universal pass to their employees, commutes by public transit have increased from 8% to 22% over the course of 16 years. Employers that purchase universal passes pay TriMet for every ride taken by one of their employees each month, and every employee is issued a pass. The 169 companies who have a universal pass program have seen a 23% decrease in the number of commuters who drive alone to work. Revenue for TriMet’s employer universal pass program has increased 1475% while the number of employees covered by the program only increased 46% over the same time period. This suggests that each employer is paying more for their transit access, but also that more employers are participating in the program. As seen in the table below, TriMet has added 108 employers since 1998.

<table>
<thead>
<tr>
<th>TABLE 3-3: UNIVERSAL PASS SALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
</tr>
<tr>
<td>2014</td>
</tr>
<tr>
<td>% Change</td>
</tr>
<tr>
<td>Employers</td>
</tr>
<tr>
<td>61</td>
</tr>
<tr>
<td>169</td>
</tr>
<tr>
<td>177%</td>
</tr>
<tr>
<td>Employees</td>
</tr>
<tr>
<td>43,596</td>
</tr>
<tr>
<td>63,848</td>
</tr>
<tr>
<td>46%</td>
</tr>
<tr>
<td>Revenue</td>
</tr>
<tr>
<td>$953,495.06</td>
</tr>
<tr>
<td>$15,022,134.34</td>
</tr>
<tr>
<td>1475%</td>
</tr>
</tbody>
</table>
The fixed price monthly pass is another option TriMet offers to employers. Employers can choose either to offer the universal pass, the monthly pass, or the annual pass to their employees. The monthly pass is more popular for employers where only a few people wish to participate in transit benefits, so the employers do not purchase universal passes for all employees. As indicated by comparing the tables above and below, offering monthly passes has been very lucrative for TriMet and allows more employers to participate (301 employers as compared to 169) than the universal pass, but fewer employees take advantage of this pass type than the universal pass.

**TABLE 3-4: MONTHLY PASS SALES**

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2014</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employers</td>
<td>185</td>
<td>301</td>
<td>63%</td>
</tr>
<tr>
<td>Employees</td>
<td>8,545</td>
<td>11,318</td>
<td>32%</td>
</tr>
<tr>
<td>Revenue</td>
<td>$3,510,613.20</td>
<td>$11,981,248.00</td>
<td>241%</td>
</tr>
</tbody>
</table>

The annual pass differs from the universal pass and the monthly pass by giving employers the option to provide their employees with 12 months of transit use for the cost of 11 months. This program is not as flexible as the other pass types because changes cannot be made on a month-to-month basis. The number of employers who participate has increased but very few employees purchase the annual pass, and TriMet receives proportionally less revenue from this pass type as compared to the other options.

**TABLE 3-5: ANNUAL PASS SALES**

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2014</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employers</td>
<td>4</td>
<td>37</td>
<td>825%</td>
</tr>
<tr>
<td>Employees</td>
<td>680</td>
<td>1,447</td>
<td>113%</td>
</tr>
<tr>
<td>Revenue</td>
<td>$360,271.50</td>
<td>$1,587,758.34</td>
<td>341%</td>
</tr>
</tbody>
</table>

Some large employers have multiple worksites and offer the universal pass across all sites. TriMet provided information for all worksites that have the universal pass and analyzed the association between parking costs, availability of carpooling spaces, and universal pass utilization. They found that of the 296 employer worksites that have the universal pass, 34% have free parking available for employees with an average number of 98 parking spaces. Of the 20 worksites that charge for parking, they charge an average of $99.80/month for a parking space. This suggests that both employers who have free parking and those who charge for it can benefit from a universal pass. A recent study by Andrea Hamre and Ralph Buehler at Virginia Tech, however, suggests that by merely offering free parking as an option, employers are reducing the likelihood that commuters will choose to take transit to work. One of the key findings of the study states that “the inclusion of free car parking in benefit packages alongside benefits for public transportation, walking, and cycling, seems to offset the effect of these incentives.” (Hamre & Buehler, 2014)
A 1999 survey in Portland found that bus/light rail ridership increased when pre-tax benefits were offered in both employee- and employer-paid scenarios. The employer-paid benefits led to a greater increase in transit usage. The researchers suspected that in the case of the employee-paid ridership increase, it was due to employees putting money into their accounts pre-tax and then riding transit more often to justify setting money aside. (ICF Consulting, 2005, p. 54)

**Case Study: Seattle and University of Washington UPass Program**

**Introduction**

The University of Washington introduced the UPass for students, faculty, and staff in 1991 to address campus parking shortages and environmental concerns. They mandated a universal pass to its faculty and staff in June of 2011, and then its students in September of that year. This universal pass program is called the UPass at the university, and the ORCA Business Passport for all other employers in the Seattle region. The UW UPass has a student advisory board who measure the effectiveness of the program, consider changes in fees and cancellations, as well as provide recommendations to the university’s student and campus-wide governing bodies. In 2009, the program marked the lowest number of car trips to UW campus since 1983 even through the total campus population has increased 28% over the same time period (UW Student Transportation Task Force, 2010).

A survey of UW students in 2009 showed that 79% of students supported implementing a universal pass UPass, which stated that all UW students would be required to pay for a pass without an opt-out option. The survey was part of a student transportation taskforce which recommended implementing a universal UPass costing between $60 and $80/quarter. The taskforce also recommended further research into pay-as-you-go transportation options, which at the time was technologically unfeasible for the university.

The Seattle ORCA Business Passport program offers unlimited use passes for most transit services in the Seattle area. Employers pay varying amounts for participation in the program based on their number of employees and location within the city. In order to participate in the program employers must purchase a passport for all of their benefit-eligible employees. The program is based on annual contracts between King County Metro Transit and the employers who wish to participate. The Business Passport requires a minimum number of 20 employees, or a minimum of 5 employees if the business is located in downtown Seattle and other highly-trafficked areas. Employers with fewer than 500 employees can provide Guaranteed Ride Home services, vanpool subsidies, and custom pricing schemas for their employees through their relationship with the transit agency. The ORCA Business Passport reduces administrative costs for employers. According to the King County Metro Transit website, “the Passport annual program does not require monthly online administration or knowledge of what type of passes employees need” (What is ORCA Business Passport?, 2013) so a dedicated
employer-side transportation coordinator is not required to send or pay a monthly bill to the transit agency.

RESULTS
Since 1991, use of the UPass on Washington’s campus has increased precipitously. As of the most recent survey in 2012, 80% of students reported using their UPass and the student drive-alone commuting rate hit an all-time low of 9% (Universal Student U-Pass Advisory Board, 2014). According to a 2004 MIT thesis, “in 2001, approximately 17% of all trips were taken using a U-Pass or FlexPass. Ridership at UW continues to increase at rates greater than population growth. The U-Pass program [...] has resulted in significant increases in transit use and decreases in SOV parking permit sales.” (Hester, 2004)

Over 450 employers in downtown Seattle offer the ORCA Business Passport to their employees including large firms like Zillow and Amazon. The Business Passport varies in price from $62.40 per employee per year for businesses located in the suburbs of Snohomish County to $614.48 per employee per year for businesses located in Seattle’s central business district. A retail-priced unlimited use monthly pass costs $1,380 annually for trips to the Seattle CBD, so the business passport provides a 50% discount to employees and offers employers the opportunity to further subsidize this to promote transit commutes to work. Employers interact with the transit agency through an online web portal that allows them to see aggregate transaction information for all employees who participate. Businesses must subsidize 50% to 100% of the cost of the pass for each employee in order to join the passport program.

CASE STUDY: MINNEAPOLIS
The City of Minneapolis promotes employer alternative mode choice through the use of the MetroPass, a universal access pass for transit in the area. Local employers in Minneapolis with more than ten employees can work with the transit authority to receive unlimited access passes to transit. Each pass is pay-per-use up to $76/month, and can be subsidized by the employer or paid for directly by each employee. The MetroPass appeals to large employers, with an average of 210 participating employees per employer in the program (ICF Consulting, 2005).

A study on the impacts of the MetroPass program found that bus ridership increased an average of 25% at worksites where the MetroPass was subsidized more than 50% (Van Hattum, 2004). This subsidy was provided through a combination of pre-tax transit benefits, the MetroPass program, and a state-wide tax credit for employers. The Minnesota Employer Transit Pass Credit was established to promote transit commutes and gives employers a 30% tax credit on any expenses related to subsidizing employee bus passes or vanpools. Offering subsidized bus passes and pre-tax transit expenses to employees resulted in a large increase in trips avoided (25% for bus passes and 5% for pre-tax transit) due to the implementation of these benefits.

FIGURE 3-4: METROPASS-MINNEAPOLIS METRO TRANSIT
Researchers in Minneapolis found that the most cost-effective TDM measures are those that discount transit and charge the full cost of driving a vehicle. In addition to providing a tax incentive to implementing TDM measure, the city also requires a TDM Plan for developments larger than 100,000 square feet and automatically requires bicycle commuting racks and showers for any development larger the 500,000 square feet. The combination of discounted transit passes and planning for employer TDM reduces SOV mode share and can promote alternative modes through positive incentives for behavior change.

**Parking Cash-Out**

Many employers offer free or subsidized parking to employees across the United States. A parking cash-out program is defined as when employers give employees the option of keeping a parking place at work, or accepting a cash payment to replace that parking space. In 2005, Donald Shoup assembled a report on parking cash-out that included case studies, recommendations for implementation and some work on the effectiveness of parking cash-out. According to Shoup and a memo from the Best Work Places organization, parking cash-out programs can be one of the most effective means to encourage non-SOV commutes. They are perceived as fair by employees since no one is forced to stop driving to work and are instead positively incentivized to choose another mode. They concluded that the best employers for this program are those that lease, rather than own, their parking spaces (EPA, 2005).

**Benefits from Parking Cash-Out**

Employers can benefit from providing parking cash-out to their employees due to the high cost of parking spaces in urban areas. Employers can save money by reducing the number of parking spaces their employees require at the workplace, especially when parking spaces cost between $360 and $2,000 annually nationwide (EPA, 2005), and up to $6,000 annually for underground parking at MIT (Moskowitz, 2012). Parking cash-out can reduce the number of leased parking spaces, as well as allow businesses to convert employee to customer/visitor spaces, use the real-estate for more productive activities, and reduce the need for building new parking in the future. According to a report on U.S. parking policies, a study on eight companies in California who implemented a cash-out program reduced SOV drivers by an average of 11% (Weinberger, Kaehny, & Rufo, 2010).

Employees of companies that implement cash-out have had large positive response to the program. Shoup found that parking cash-out increases employee satisfaction and helps recruit and retain employees, providing a more equitable benefits package to all employees. Parking cash-out rewards those who choose not to drive without penalizing those who must continue to drive alone to work.

Parking cash-out has low administrative oversight and costs. Implementation can be simple and straight-forward, most of the time requiring only that an employer payroll system can account for
some employees opting to take additional taxable funds. Employers are not required to distribute transit passes or any vouchers under a traditional cash-out program.

**Potential Issues with Parking Cash-Out**

Employers that own their own parking or who are unable to re-negotiate with their landlords regarding the number of leased spaces they require are less likely to be interested in parking cash-out. If parking cash-out can help reduce the need for expanded leased spaces or the building of new parking lots, however, cash-out should still be considered for these employers.

Employers with a large non-SOV mode share may believe that providing a parking cash-out to every employee, including non-drivers, would be expensive as many employees already choose not to drive alone to work. Cambridge has many employers whose employees commute by MBTA or bicycle/walk to work. Similarly, Stanford University has approximately 39,000 commuters and has reduced its SOV mode share from 72% in 2002 to 41.8% in 2013 (Levin, 2013). With a current low SOV mode share, Stanford addressed the issue of providing incentives to non-drivers by offering a smaller cash-out amount to all members of the community who sign up for their Commute Club ($25 per month, up to $300 per year). The program allows access to a limited number of daily parking permits (up to 8 per month) while offering cash rewards for walking, bicycling, or taking transit to Stanford. Significantly less than the full price of parking on campus, this program design rewards non-SOV commutes while allowing for occasional parking. It is considered a partial cash-out program and partial cash-outs can be just as easy to implement and may be more appealing to those organizations with a current large non-SOV mode share population.

Data collection and review of the effectiveness of cash-out programs is another potential issue with the program design. A 1992 California law requires that companies with more than 50 employees and who subsidize parking offer a parking cash-out program to their employees. However, the law does not require regular surveys or any type of data collection to ensure that employers are complying with the regulation. In 2015, the California Air Resources Board does not have information on how many employers or employees participate in the cash-out program and at its inception the law had jurisdiction over only 3% of 11 million free employer parking spaces in the state. One of the employers participating in the program who began participating in the mid-1990s now only has 12 of 185 employees opting for the $215/month subsidy and studies show that 90% of Los Angeles and Orange county commuters have access to free parking at work (Weikel, 2015). Low participation rates and no parties collecting data or enforcing legislation impedes the growth of parking cash-out programs. Those employers that implement parking cash-out should be sure to plan for review of the program and keep the marketing fresh and up to date as part of the benefits package.

Geographic equity is also a concern in parking cash-out program design. In a study of employers in Minneapolis/St. Paul, employers with multiple work sites were compelled to offer the same transportation benefits across sites, which meant that downtown offices were to be offered the same benefit as suburban sites even if only the downtown offices had leased parking spaces from which to
generate income to run the program. Employers were not interested in offering a parking cash-out if it meant treating different work sites separately in the benefits pool (Hattum, 2000).

**CASE STUDY: PARKING CASH-OUT**

In 2005, Shoup studied eight employers who implemented parking cash-out strategies and analyzed the results of these implementations. He found that the programs “reduced vehicle travel to work at participating firms by an average of 12 percent.” (Shoup, 2005) This is equivalent to removing one in eight cars from a morning commute. Shoup found that implementing the programs cost employers on average $2 per month per employee while improving employee satisfaction and retention. According to Shoup, “in most cases, parking cash-out is simply a more flexible use of money firms already pay to subsidize parking.” (Shoup, 2005) Carpooling usage increased 9%, transit increased 3% and walking increased 1% in these studies after the cash-out was introduced. Shoup argued that three times more drive alone commuters switched to carpools than transit, suggesting that cash-out can be effective even when public transit is a poor option.

Shoup found that drive-alone mode share fell from 76% to 63% after introducing cash-out. In a study of seven Minneapolis companies, they found an average of 11% mode shift from SOV to other modes (Hattum, 2000) after the introduction of a parking cash-out in combination with a universal transit pass incentive program. Bus ridership in the Minneapolis study increased 47% overall and one particular downtown company saw an increase in bus commuting from 47% to 68% over an 18 month period (Hattum, 2000). Hattum suggested that a critical challenge with implementing parking cash-out programs is funding the incentive long-term. Once employee payments for leased parking spaces have been reduced or eliminated, employers no longer have a revenue source to pay for the cash-out. Also, he found that marketing was a significant challenge and many employers were not interested in participating because they owned their own parking or did not wish to identify a person to administer the program.

**“BIKE TO WORK” AND OTHER SHORT-TERM INITIATIVES**

Often municipalities and employers will promote single-event initiatives such as “Bike to Work” days or a Clear Air Challenge to promote alternative commutes over a short period of time. As suggested in Chapter 2, these short-term projects do not always lead to long-term behavior changes, but can produce a positive impact if implemented effectively. One study of a “Ride to Work Day” event in Victoria, Australia found that among those who were riding a bicycle to work for the first time as a result of the event, 27% were still riding to work at least one day a week five months later. Additionally, more than 80% of first time riders stated in a follow-up survey that the event had a positive impact on their readiness to ride to work. Researchers found that the event had a larger influence on women than on men and that 57% of first-timers stated that the event influenced their decision to ride to work five months after the event took place. Among female survey respondents, 23% rode to work for the first time during the event and 30% rode to work during the survey week five months later. Attracting thousands of participants annually, one in five participants of the studied “Ride to Work Day 2004” event were first-time riders (Rose & Marfurt, 2007).
The underlying behavioral model associated to this kind of single-event initiative focuses on the stages of behavior change proposed by Prochaka and DiClemente in 1983. As seen in the table below, a “Bike to Work” event asks participants to respond to statements about their thinking process surrounding riding to work. They are then considered to be in a “behavior change stage” based on their response.

<table>
<thead>
<tr>
<th>Behaviour change stage statements</th>
<th>Corresponding behaviour change stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am not even considering riding to work</td>
<td>Pre-contemplation</td>
</tr>
<tr>
<td>I am thinking about riding to work but I am not ready to give it a go</td>
<td>Contemplation</td>
</tr>
<tr>
<td>I have tried riding to work once or twice</td>
<td>Preparation</td>
</tr>
<tr>
<td>I am riding to work infrequently (less than once a week)</td>
<td>Maintenance A</td>
</tr>
<tr>
<td>I am riding to work fairly regularly (at least once a week)</td>
<td>Maintenance B</td>
</tr>
</tbody>
</table>

(Rose & Marfurt, 2007)

Each behavior change stage corresponds to a stage in the model seen in the figure below. The Pre-contemplation stage refers to a participant being unwilling or too discouraged to try a change. In the Contemplation stage, participants are open to information, evaluate options for change, and are seriously considering a change in the next six months. Preparation stage includes participants who are determined to take action in the next 30 days and have a sense of commitment to the change. The Action stage includes an overt change in behavior in the participants. Maintenance refers to an Action sustained over a period of six months or more. In the case of this study, there were two levels of Maintenance (A & B) referring to the frequency of biking to work (Rose & Marfurt, 2007).

![Figure 3-5: Model of the Stages in Behaviour Change](Prochaka & DiClemente, 1983)

**FIGURE 3-5: MODEL OF THE STAGES IN BEHAVIOUR CHANGE**

Approaches to moving participants through the stages vary based on the stage they are in. During the pre-contemplation stage, participants should be provided with nonjudgmental information (such as the modal split of their community). During the contemplation stage, they should have access to assistance in evaluating the benefits and costs of changing their behavior and supportive resources. During the preparation stage, researchers should gain commitment to action from participants and assist in goal-setting. The Action stage should encourage the behavior change by encouraging rewards and reinforcing social support for bicycling. The Maintenance stage should remind participants of achievements and encourage sticking to the behavior change challenge (Prochaka & DiClemente, 1983).
A similar study of the long-term effects of a “Bike to Work” event took place in Washington, D.C. The researchers found that of those who rode to work for the first time during the event, 38% stated they rode to work after the event. Additionally, 14% of survey respondents who were previously riding to work stated that they were riding more frequently after the event, indicating that the initiative increase the rate of people choosing to bicycle to work. One third of the participants stated they used their bikes more often for other trips (outside of work commutes) after the event than before (Rose & Marfurt, 2007).

These studies suggest that even single-time events can be effective in creating long term behavior change towards more sustainable commuting options. Following the suggestions for tailored responses to those participants in each behavior change step can lead to a successful mode shift for a portion of the employer population. Although seemingly short-sighted due to its brief duration, research shows that people will prepare and take steps to participate in a “Bike to Work” event and change their behavior as a result. A single event introduces a new mode in an accessible and fun manner, leading to sustained expansion of options for future work commutes.

**BIKESHARE/CARSHARE SUBSIDY**

Bikeshare literature suggests that subsidies for the service result in mode shift from other sustainable modes, and not directly from private car use. Studies performed on bikeshare users asked what mode they would have used if they did not use bikeshare for a particular trip. These surveys took place in Washington D.C., Lyon, Dublin and Minnesota and resulted in the mode breakdown seen in the figure below.

![Mode breakdown figure](image-url)
As seen in the figure above, in three of the four cities 7% of bikeshare users surveyed would have used a car for their journey, while the large majority would have walked or taken public transport. Therefore, it may not benefit employers who wish to reduce their driving alone commuter population to offer a subsidized bikeshare membership. However, according to one study on change in mode use due to bike share in North America, 40% of respondents said they use their car less often or much less often due to bikeshare. The remaining 60% stated that they saw no change in their car use due to bikeshare (Fishman, 2013). A study on trip purpose for Capital Bikeshare in Washington D.C. found that 38% of bikeshare users had taken their most recent bike trip to commute to or from work, and commuting was the most common trip purpose across North American system (LDA Consulting, 2012). Bikeshare can reduce the amount of private bike parking needed at employer sites and costs little to subsidize.

CARPOOLING OFFERINGS

Another incentive that can be included in a transportation demand management strategy is the promotion and management of carpools and vanpools for large employers. According to one study measuring the effects of employee home location, employer organization type, and carpool promotion on carpooling popularity, carpooling in transit-heavy areas can create competition with public transit and can be counterproductive towards the cause of reducing the number of vehicles commuting to the employer (Vanoutrive, 2012). According to most studies, psychological barriers, attitudes and perceptions have a larger influence on whether an employee chooses to carpool than socio-demographic information (Vanoutrive, 2012). According to researchers, people find employer or school affiliation a quick and comfortable way to decrease the “stranger barrier” in organizing carpools (Ozenc, Cranor, & Morris, 2011). A majority of participants in one study agreed that social networks should be used to link friends of friends or interest groups together to make carpools.

A study of carpooling in Dallas-Fort Worth and Houston found that carpool users rated the ability to use high-occupancy vehicle (HOV) lanes highest in their decision to ride in a carpool. They found that the next most important factors were socializing during the commute, then saving time and sharing car costs, and then helping the environment. Lowest ranked factors by carpool commuters were employer carpool incentives and preferential parking at employer sites (Li, et al., 2007). The researchers determined that travelers on commuting trips ranked travel time savings and sharing of vehicle costs much higher than non-commuters.

Researchers that measured the effects of carpool promotions found that the guaranteed ride home programs are effective in increasing carpooling mode share. There are studies that suggest financial incentives to carpool may increase carpooling mode share (Li, et al., 2007). However, a study by Hwang and Giuliano found that disincentives such as parking charges and restrictions on SOV parking are more effective at increasing carpool mode share than incentives such as marketing, setting up matching services, and giving preferential parking to carpoolers (Hwang & Giuliano, 1990).

CASE STUDY: STANFORD CASH PRIZES/LOTTERIES

Stanford has helped lead the way in TDM measures for large employers with programs focused on reducing the number of cars on campus and promoting active and sustainable commutes. In 2000, the
county of Santa Clara granted the university the permits it needed to expand significantly and in return Stanford agreed to keep peak-level car commuting rates from increasing from the current level. Since then, Stanford has introduced a variety of policies and procedures aimed at reducing SOV mode share. The university’s parking office introduced the Commute Club, which offers a number of benefits including up to $300 per year to those staff and faculty who choose not to purchase a parking permit. The benefits also include free transit passes, membership in a guaranteed ride home program, access to the purchase of up to eight daily parking passes per month, Zipcar driving credits, hourly rentals from Enterprise, and automatic entry into prize drawings. Stanford has seen an SOV mode share reduction from 72% to 47% between 2000 and 2013 (Schmitt, Streetsblog USA, 2013).

From 2012 to 2014, researchers at Stanford tested the effects of incentives and prizes on shifting demand from peak to off-peak times and shifting mode share from driving to alternatives. Participants opted-in to the program and received points and prizes for not parking on-campus. The researchers awarded participants points based on whether they chose to drive and park on-campus or take public transportation, walk or bicycle. Points could be redeemed for cash either deterministically (trading 100 points for $1), which equaled one week’s worth of off-peak trips, or by playing a randomized game that distributed between $2 and $50 each time a participant played. The study found that 87.3% of all participants played the game instead of receiving the deterministic value of the funds. The cash rewards were paid to participants through direct deposit. Each week, participants were given the option to choose the deterministic prize or play the game and over the course of the experiment, 13.2% of participants switched from deterministic to the game (Zhu, et al., 2015).

"You probably wouldn’t jump out of bed early every day for 10 cents," said Prabhakar. "But the raffle effect, where a small amount of money seems like a lot, is well established." (Golden, 2012)

In addition to the weekly games, the researchers also offered specialized “bonus” days that tripled the number of points distributed to certain individuals for not driving to campus. Participants were divided into status levels of Silver, Bronze, Gold and Platinum depending on the number of points they had accumulated over the course of a week. The higher statuses allowed participants to play games for higher prize payouts. They also offered “magic boxes” which offered a number of additional points or bumped individuals up into the next status level. Researchers found that those participants who recently received a prize were more likely to shift their commute time away from the peak (thus giving themselves the opportunity to win more prizes) than those who had not received a prize recently. They also observed a relationship between the behavior of a participant whose friends had recently won prizes on their commute timing (Zhu, et al., 2015).

Below in Figure 3-6 is the dashboard the Stanford experimenters used to display user parking information and point accumulation to the participants. The application allows participants to track their behavior as well as the behavior of their friends (who were added by searching for their username on the site), collect points, and play the game seen in Figure 3-7 on the next page to win prizes for their commutes.
The game was based on a version of Chutes and Ladders and participants could have the game auto-played for them so that they could still win the randomized prize without devoting the time to playing an online game. One of the researchers stated, "if my [commuting] behavior is better, I can go to a higher area, where there's higher odds of winning." (Farivar, 2012) The object of the game play was
to move beyond a simple, straightforward lottery where some participants win while others lose. In this scenario, each participant is a winner and the researchers could measure the impact on behavior of offering a lottery to each participant, not just the ones who won the prizes.

3.3.2. DISINCENTIVES
This section describes the disincentives imposed upon employees to motivate them to reduce their single-occupant vehicle commutes. The section includes a discussion on parking pricing schemes in combination with discounted transit passes, as well as the impact of daily versus monthly parking rates on parking behavior. Studies on the negative impact of free or subsidized parking on SOV behavior are also included.

**PARKING CHARGES**
Charging employees for parking at their workplace is the single largest determinant of commuting mode choice (Hamre & Buehler, 2014). Donald Shoup has written extensively on the influence of free parking on people's decisions to take trips in the U.S., where 90% of the workforce drives alone to work (Shoup, 2005). According to a study estimating the effects of employer-paid parking on demand, 25 to 34% fewer cars are driven to work when employees must pay to park as compared to when they park for free (Willson, 1992). In many cities, however, employees already pay a fee for parking but it is usually partially subsidized by their employers and therefore does not reflect the true cost of parking at urban worksites. By increasing the cost of parking at these worksites to better represent the true cost of parking on valuable real estate, employers can introduce a powerful disincentive to driving to work.

A study in Vancouver which presented a discrete choice survey to 548 participants who currently drive alone to work found that increases in drive alone costs through road charges or parking charges made the largest impact on choosing an alternative and decreasing the demand for single-occupant vehicle commutes. Other factors examined were the time and costs of alternatives as well as an increase in SOV travel time, all of which did not have the same large impact that increasing the cost of driving did to the commuting choice of survey participants (Washbrook, Haider, & Jaccard, 2006).

According to a nationwide study of universal passes, the biggest increases in transit ridership from universal passes are seen in high-transit mode share areas like Boston (ICF Consulting, 2005). In Portland’s high-density commercial Lloyd District, an experiment on increasing the cost of parking while also providing discounted transit passes resulted in a 19% decrease in the number of employees who drove alone. The pricing policy changes also increased carpooling 41% and transit usage 12%. For companies in the Lloyd District that did not offer a discounted transit pass alongside the increased parking costs, the researchers found a 2% increase in driving alone and 36% reduction in transit usage, although carpooling increased 20% (Bianco, 2000). The Lloyd District improved its transit commute mode splits from 21% in 1997 to 41% in 2008, while increasing the number of employee transit passes distributed from 1,250 to 6000+ over the same time period. The Lloyd District is a good example of the effectiveness of combining incentives and disincentives to change commuting behavior.
**DAILY VERSUS MONTHLY PARKING RATES**

Drive alone commutes can be reduced through the introduction of daily parking rates, where employees pay for each day they park. In a 2005 TCRP report on parking pricing policies, parking demand elasticities generally fall within the range of -0.1 and -0.6 with a mode of -0.3 (ICF Consulting, 2005). Commuters value out-of-vehicle costs such as parking higher than in-vehicle costs (such as gas expended) when determining whether or not to drive to work (Feeney, 1989). Employers that offer a monthly or annual parking pass put employees in the position to decide between driving to work, which thereafter has zero marginal cost, and the cost of a transit trip above what they have already spent on parking each day. In the short-term, this decision tends to lead toward driving to work more heavily because the employee has already paid for the parking space in advance.

The City of Seattle assembled a best practices document for TDM measures that included a recommendation to transition from monthly to daily parking charges (City of Seattle, 2008). By allowing employees to purchase individual parking days on a pro-rated basis, employees can make a daily decision between driving alone and alternative means of commuting. A 2004 survey of BART users in San Francisco were asked about their thoughts on switching from monthly to daily parking charges and of those who currently paid for the monthly pass, only 18% said they would use a paid daily parking service (Rodier, Shaheen, & Eaken, 2005). This low percentage can be attributed to the fact that the daily paid parking at the time required participants to pay with cash each day, while the monthly pass cost was paid by monthly check, making the daily parking charge a larger burden on the commuter.

Stanford researchers measured the price elasticity of parking demand on campus for a daily parking rate versus an unlimited monthly rate and found that the elasticity of daily parking was -1.22 while monthly was -0.97 (Ng, 2014). This suggests that increasing the price of daily parking will decrease parking 25% more than increasing the price of monthly parking because employees are willing to pay more for what they consider a fixed, upfront cost that can be amortized over the month than for a daily parking rate for which they must think about the purchase each time they park.

### 3.4 SUMMARY OF EMPLOYER TDM PROGRAMS

This chapter introduced the topic of employer-based transportation demand management programs, summarized national examples of TDM research and provided a list of incentives and disincentives for consideration in future TDM projects. Incentives such as a universal access pass to transit, parking cash-out, bikeshare and carpool subsidies, and offering financial prizes in the form of a lottery were found to have a substantial effect on changing mode share. Additionally, charging for the actual cost of providing parking and transitioning from monthly to daily parking charges were found to be effective at reducing drive alone commuting behavior. The next chapter focuses on examples of TDM programs in Cambridge and contains a summary of the results of TDM implementations at MIT.
CHAPTER 4

4. CAMBRIDGE AND MIT TDM

This chapter contains an introduction to transportation demand management measures in Cambridge and MIT. It begins with a history of TDM in Cambridge and trends in TDM in the Kendall Square area. A summary of the takeaways for Cambridge and Kendall Square from national case studies discussed in the previous chapter is included. The next section discusses the history of TDM at MIT and provides a list of the current incentives provided by MIT for its employees and students. The chapter concludes with a summary of the 2014 MIT Commuter Survey and the MIT/MBTA Mobility Pass pilot results.

4.1 TDM IN CAMBRIDGE, MASSACHUSETTS

In 1998, Cambridge passed an ordinance to require that Parking and Transportation Demand Management (PTDM) measures be put into place to reduce single-occupancy vehicle commutes into the city. This program is unique to Cambridge in that it requires businesses to provide proof of promoting active and non-SOV commutes when they build five or more parking spaces for non-residential property in the city. Participants have an individual contract with the city specifying what is required for that project (e.g., SOV mode share %, bike parking spaces, electric vehicle spaces, etc.). Participants must submit annual reports of the efforts they are making to follow PTDM which includes current SOV mode share, number of parking spaces, bike facilities, showers, transit memberships, etc.

The Cambridge ordinance increases the transportation benefits offered to area employees by their companies and organizations. It also helped make Cambridge #10 on Bicycling Magazine’s Top 50 Bike-Friendly Cities in the United States. According to the Boston Globe in 2012, even though commercial and institutional space in Kendall Square has increased 40% since 2002, there has been a 14% decrease in vehicle counts over the same period (Moskowitz, 2012).

Despite the positive benefits of the PTDM program, there are issues associated to its design. Currently not all companies in Cambridge are required to participate, including many who have not added parking since before the ordinance. Additionally, it has created issues between developers of properties and the employers who fill these properties after they have been built. Employers may not have control over how many parking spaces were built as part of the developer plans and therefore have little motivation to reduce their spaces if their building lease contract with the developer requires a minimum number of spaces as part of the lease.

To help in the implementation of many of these initiatives, a consortium of 25 companies founded the Charles River Transportation Management Association (CRTMA) in 1995. These companies determined that they could save on the costs of providing TDM programs if they combined their efforts and their funding to create a unified set of services. The CRTMA consolidated fifteen private company shuttles into seven EZ Ride buses that operate in the Kendall Square area, connecting three
major transit hubs to Cambridge employers. As seen in the figure below, the EZ Ride shuttle connects North Station, Lechmere, Kendall Square and MIT campus together and accesses the portions of Cambridge that are underserved by the MBTA.

FIGURE 4-1: CRTMA EZRIDE ROUTE, 2015 (CRTMA, 2015)

4.1.1 TRENDS IN TDM IN CAMBRIDGE AND KENDALL SQUARE
The implementation of PTDM in Cambridge has made the city a national leader in demand management and show what these policies can do to improve mode share.

In late 2006, the MBTA introduced the CharlieCard to replace paper tickets on the subway and buses. The smart card is refillable and can accommodate stored value and monthly pass accounts on the same card. The CharlieCard allows for individual's trips to be tracked and for usage to be measured over time.

In Cambridge, the most recently estimated mode share for commuting to work by public transportation is 26.9%. The means of transportation to work other than driving alone (i.e., transit, walking, biking, carpooling, or taxi) is 63.3%, while driving alone is 29.8% of commuter trips (U.S. Census Bureau, 2013). The MBTA currently charges $2.10 per subway trip and $1.60 per bus trip, following legislation that allows an average of a 5% fare increase every two years. The monthly LinkPass costs $75 per month and MIT subsidizes 50% of the cost of the monthly pass, as well as 50% of the cost of commuter rail passes. The MBTA offers college and university students an 11% discount on a semester pass, and offers a corporate pass program for employers to distribute monthly passes on-site and provide their own subsidies to employees to promote transit use.

As indicated by the Charles River TMA EZ Ride service expansion, companies in the Kendall Square area are increasingly interested in improving their TDM incentives. The city of Cambridge PTDM office is tracking over 30 projects annually for various developers and employers in the Kendall Square
area. Additionally, within the year 2014, a city partnership with a company called TransitScreen has brought multimodal transportation real-time information/marketing screens to city buildings. As part of the 2015 Cambridge community vote for small project funding, Cambridge residents voted to spend a portion of the $500,000 budget on adding outdoor TransitScreens to two major bus stop locations in order to provide information on bus arrivals, bikeshare bicycle and dock availability, ride-sourcing companies like Uber, and carshare availability nearby (Monsegur, 2015). Cambridge residents and businesses voted for TDM projects like TransitScreen over public park redevelopment, art installations and a dog park. This suggests that transportation demand management tools are being recognized as valuable to the community and should be supported.

In an analysis of commuting trends in the Kendall Square area, the census tracts highlighted in red on the map below (Figure 4-2) were examined for changes in commuting behavior.

![Figure 4-2: 2010 Cambridge Census Tract Boundaries](image)

According to the American Community Survey, from 2010 to 2013 5-year estimates, the highlighted census tracts grew from a working population (over the age of 16) of 9,350 to 10,017 (7.1%) over the four year period. Over the same time period, the SOV mode share of residents dropped from 25.1%
to 22.7% (U.S. Census Bureau, 2013). In the year 2000, the entire city of Cambridge had 54,959 workers over the age of 16 and SOV mode share was 35% (U.S. Census Bureau, 2000). Thirteen years later in 2013, the population of workers in Cambridge increased by approximately 6.5%, SOV mode share decreased by 10.2% to a Drive Alone mode split of 29.8% (U.S. Census Bureau, 2013). This reflects both the fact that employees who live closer to work are more likely to use transit, walk, and bike, and some increase in transit use for longer trips as well. In Figure 4-3 below is a breakdown of commute mode share from 2000 to 2013. Public transportation has increased as well as working from home and taxicab commutes. Walking decreased slightly and carpooling also declined over this time period. The largest percent change was the number of people who commuted by driving alone (which decreased), followed by the increase in bicycling. The number of people commuting by bicycle in Cambridge almost doubled between 2000 and 2013. Transit increased by 7.1% over the same period from 25.1% to 26.9%.

![Graph showing commute mode share from 2000 to 2013 for Cambridge.]

**FIGURE 4-3: CAMBRIDGE MEANS OF TRANSPORTATION TO WORK, 2000 TO 2013 (U.S. CENSUS BUREAU, 2013)**

A combination of factors most likely led to the decrease in SOV mode share both in Cambridge and, more specifically, in the Kendall Square area. Nationwide, vehicle miles traveled peaked in 2005 and have remained steady or decreased each year since then (Mc Cahill & Spahr, 2013). Cambridge partnered with Hubway to install a bikeshare network and expanded the number of protected and unprotected bicycle lanes throughout the city, as well as installed bike racks on all major roadways. New developments in Kendall Square for residences and office space have offered their employees/residents large transit subsidies (sometimes up to 100% subsidy) and more young people are choosing to live in Cambridge without a car.

4.1.2 **TAKEAWAYS FROM NATIONAL CASE STUDIES FOR CAMBRIDGE AND THE MBTA**

The following section addresses takeaways from national-level case studies on TDM incentives and their implications for Boston, Cambridge and the MBTA. The section discusses universal pass considerations, parking cash-out implementations, and short-term challenges in the Cambridge area.
Universal and Employer Passes

According to an MIT master’s thesis on introducing a universal student pass to Boston, passes have the “potential to internalize the otherwise external benefits of transit use, such as reduced pressure on limited amount of expensive parking supplies and access roads. It thereby achieves a 'win-win' outcome for all of the primary affected groups, while maintaining equitable revenues, increasing ridership and improving off-peak utilization.” (Hester, 2004) These employer-based passes have been introduced in Portland and at the University of Washington as discussed in Chapter 3, and each of these implementations can be used to shape the corporate pass program at the MBTA. Specific recommendations for changes to the MBTA program can be found in Chapter 5, but a description of best practices for universal passes in Boston is provided in this section.

Portland Employer Passes

Out of 169 total employers in the TriMet universal pass program, 120 employers subsidize more than 30% of employee transit costs. These companies employ over 53,000 people who participate in the program and these companies have a transit mode share of approximately 32%. The companies vary in size from four people to 15,000 and the program is flexible enough to accommodate employers who wish to offer pre-tax incentives, post-tax incentives, monthly passes, annual passes and universal passes to its employees. Since Boston is filled with a diverse set of employers and has a significantly higher transit mode share to begin with, flexibility in the transit pass design and the ability to accommodate employers of all sizes will allow the city to reap the same benefits Portland is currently receiving with its corporate pass program.

TriMet bills its employers based on “active use,” which is measured using commuter surveys sent out to employees. Generally speaking, the bills are calculated based on multiplying the transit mode share determined by the surveys by the annual pass cost and the number of company employees. This is an inexact process that could reduce the potential revenues collected by the transit agency due to “misremembering” trips made by transit. The MBTA has the advantage of smart card technology that allows their billing process to be more exact if a similar universal pass program is introduced. The CharlieCard numbers are already associated to employers and the employers can be billed based upon the usage of individual employee trips each month.

The TriMet universal pass allows for employers to vary their transit subsidy rates and allows condensed or non-standard work week employees to participate, expanding the number of employees who can occasionally choose more sustainable commutes. Portland employers can contribute anywhere from 0% to 100% subsidy to their employee’s commutes and the more they contribute, the higher the percentage of transit ridership. According to one study from 1999, the Portland universal pass “employers showed the highest average increase in transit ridership.” (ICF Consulting, 2005, p. 55) Using Portland as a test case, Boston can implement a universal pass with confidence knowing that transit mode share, ridership and revenue will increase as a result.
University of Washington UPass Program

Seattle and Portland have different commuting patterns (Seattle has higher transit usage while Portland has a larger bicycling modal split), but both have benefitted from the introduction of the employer universal transit pass. Boston can also benefit from a program like the ORCA Business Passport, the UW UPass or the TriMet Universal Pass. As you can see in Figure 4-4 below, the Boston, Portland and Seattle metropolitan areas have similar Drive Alone mode share for commuting trips. Boston has slightly higher public transit use, but generally follows a similar breakdown to the other cities.

![Figure 4-4: 2013 Commute Mode Share: Boston, Portland, and Seattle Metropolitan Areas (U.S. Census Bureau, 2013)](source)

Seattle’s universal pass offerings (the UPass and ORCA) have increased ridership and reduced SOV rates city-wide. The MBTA has the technology to track individual employees using their CharlieCard numbers and is capable of offering a similar universal pass system with much greater ability to interpret the results of putting a program in place in real time. Based on findings from Seattle’s program, having a universal pass program option for companies that subsidize 50-100% of transit costs provides increased revenue for the transit agency and lower administrative costs on a monthly basis for both the employer and the transit agency.

Parking Cash-out Takeaways

Parking cash-out, or partial cash-out, can be a viable option for those Kendall Square employers who currently lease parking spaces from their property owners or those that could benefit financially from a reduction in parking on site. Cash-outs are used to promote transit use in many urban areas because

Source: US Census Bureau, 2009-2013 American Community Survey

FIGURE 4-4: 2013 COMMUTE MODE SHARE: BOSTON, PORTLAND, AND SEATTLE METROPOLITAN AREAS (U.S. CENSUS BUREAU, 2013)
transit is the next most-frequently used commuting mode after driving alone. Although Kendall Square has many transit options, focus groups of MIT commuters suggest that public transportation is not a good option for some employees and emphasizing carpooling when introducing cash-out may improve commuting for MIT. Offering funds in place of a parking space incentivizes those drivers who do not have access to transit to continue to try other alternatives such as carpooling.

Offering employees a fixed amount each month towards their transportation expenses often changes the commuting decisions employees must make (e.g., they no longer need to decide between a subsidized parking space or a reduced-price transit pass on a semi-permanent, full-time basis). Employers can promote alternatives without negatively affecting those who have no choice but to drive. By offering a portion of the cost of providing parking to employees (partial cash-out), employees and employers share the burden of the cost of the parking spaces while still maintaining the benefit of employer contributions to employee’s commutes.

4.2 TDM at MIT

4.2.1 History of MIT TDM Programs
In the 1950s, MIT developed a parking supply problem and a committee task force was brought together to consider adopting a parking fee to reduce the demand for parking on campus. The task force recommended charging an annual fee of $20 ($167 in 2015 dollars) to the approximately 2,500 employees and students who parked on campus (The Tech, 1957). The recommendation was ultimately not put in to place and until 1975, parking on campus at MIT was free to employees. In 1975, an administrative fee of $5 was assessed to all parkers and this fee rose to $10 by 1990 (Hester, 2004). However, in 1973 the federal government signed the Federal Clean Air Act into law, requiring that MIT provide only enough parking spaces to accommodate up to 36% of its commuters. In that same year, Cambridge enacted a parking freeze that reduced any future parking space growth, but allowed the current parking spaces above the limit to remain in place without falling under the regulation (Hester, 2004).

In 1993, MIT offered access to select campus parking garages through the MIT ID card and this process has continued to today, allowing access to parking usage for 65% of the spaces on campus (Block-Schachter, 2009). The remaining 35% are un-gated and cannot be tracked through the MIT ID presently. In the late 1990s, MIT introduced a new cost-based fee for campus parking and by 2001, a parking permit cost $400/year. It was at this time that the administration began the policy of increasing parking prices by 11% each year to help gradually recover the costs of providing parking on campus. Outside of a 2004 salary freeze, the 11% increase policy has continued to today (Block-Schachter, 2009). Currently, the parking fees cover 58% of the cost of providing parking on campus.

On the transit side, MIT began offering a $10 per month transit pass subsidy to all students and employees in 1996. The program was put in place to help the campus “comply with clean air standards, as an encouragement for the use of mass transit,” according to the chair of the Institute Parking and Transportation Committee at the time (Chuang, 1996). Between 1996 and 2008, the subsidy rose to
50% of the cost of a transit pass for all passes including commuter rail. However, at 50% subsidy, some commuter rail pass costs were above the allowable federal pre-tax benefit limit of $130 per month. In these cases, MIT placed an imputed income charge on employees’ paychecks for the amount between the 50% subsidy and $130 (Block-Schachter, 2009).

In addition to parking and transit subsidies, MIT also offers Zipcar subsidies to its employees and students. Zipcar and MIT formed a partnership in mid-2002 and within a few months, they had 250 employees and graduate students signed up for the carshare company. An initial survey of participants indicated that 20% were using Zipcar instead of buying a car (Zaman, 2002). MIT employees had their initial insurance fee of $300 and their $50 application fee paid for by MIT and were only required to pay an annual fee of $20 plus rental charges. The $20 annual fee was credited to driving time (Zaman, 2002). From 2002 until 2011, undergraduates at MIT were not allowed to participate in the Zipcar program. In 2011, MIT made an agreement with Zipcar that undergraduates over the age of 18 could rent vehicles from Zipcar while on MIT campus. The program today costs $15 for MIT students and $25 for employees annually and it has 6,220 members on campus as of 2014.

Bikeshare is another transportation demand management offering MIT provides its employees and students. MIT began offering bikeshare subsidies in 2012, as the service expanded to Cambridge and MIT sponsored two Hubway stations on its campus. At the time, Hubway charged $50 per year for a corporate membership (an individual membership costs $75) and MIT offered memberships to its students and staff for $25 per year. In 2014 there were 1,383 MIT Hubway members among faculty and students (MIT Parking and Transportation Office, 2014). Hubway had 12,673 total annual memberships in 2014 (Hubway, 2015), suggesting that almost 11% of the total Hubway annual memberships were held by MIT community members. Of the top ten most popular Hubway stations in 2014, six are within a half mile of MIT campus and the most popular station is “MIT at Mass Ave” with 68,660 station visits that year. For a breakdown of the trips made from all of the most popular stations from 2014, see Figure 4-5 below.
FIGURE 4-5: TOP TEN MOST POPULAR HUBWAY STATIONS RIDERSHIP, 2014 (HUBWAY, 2015)

MIT participates in all of the pre-tax transportation benefits offered by the IRS including the transit, parking and bicycling benefits. The Institute allows its employees to set aside pre-tax funds to purchase transit passes (up to $130 per month), pay for parking on campus (up to $250 per month), and get reimbursed for bicycle expenses (up to $20 per month).

MIT also offers entry into an Emergency Ride Home program at no cost to its employees. Run by the Charles River Transportation Management Association, employees of TMA member organizations who do not purchase an annual parking pass may participate. The program allows for free taxi vouchers to be used by the employee in case of emergencies such as a sick child or an unexpectedly long stay at work that would cause the employee to miss their bus, train or carpool home. One of the founding offerings of the Charles River TMA, guaranteed ride home programs have been successful in decreasing SOV mode share, but they tend to be under-marketed to employees in Cambridge. In 2004, only 144 MIT employees participated in the program. In 2014, the number of participating employees rose to 661 (MIT Parking and Transportation Office, 2014), but this is still a very small percentage of all the possible employees who are eligible for the benefit.

One possible explanation for the limited popularity for the program is that the process of signing up and then using the benefit is not very technologically advanced. Instructions on the MIT Commuter Options webpage tell employees to register on the CRTMA website, then wait up to three weeks for processing, then receive a taxi voucher in the mail and fill it in by hand when you need to use the voucher in an emergency (MIT Department of Facilities, 2015). This process requires the employee to keep track of a physical paper voucher that was mailed to their home in case one day they need to use it to get home from work. Transitioning this process into a completely paperless format and
promoting it as such to MIT employees may increase use of the program. In its current state, it may not seem as valuable to the employee as other TDM benefits.

Subsidies and matching services for carpooling and vanpooling are also offered to MIT employees as part of the Institute’s TDM initiative. Carpooling has been emphasized on campus since the mid-1970s after the Clean Air Act required MIT to reduce its parking spaces. Currently, MIT offers a 50% subsidy off of the annual parking permit to the primary carpool member, and all other carpool members pay the primary member for their share of the rides. Vanpooling has been a part of the MIT commuting program since the mid-1980s when they partnered with VPSI, Inc., a vanpooling organization founded in 1977. Transitioning from VPSI to vRide, MIT began a vRide pilot project in 2012 that offered employees a $100/month subsidy as well as the opportunity to have their commuting gas and parking paid for by the program. In 2014, 49 people participated in five vRide vanpools that originate in towns as far from MIT as Springfield, MA (MIT Parking and Transportation Office, 2014).

MIT offers its employees discounts on on-campus parking for those who drive an ecologically-friendly vehicle. Employees can receive a 20% discount on parking permits for a “SmartWay Elite” vehicle, which includes the electric and hybrid cars currently on the market. Introduced by the EPA in 2007, the SmartWay program was aimed at promoting environmentally conscious vehicles and reduce greenhouse gas emissions. In 2014, 67 MIT employees received the benefit (MIT Parking and Transportation Office, 2014).

The free shuttle service for campus students and employees is also a benefit MIT offers. Introduced as an on-demand nightly “Safe Ride” van in the spring of 1991 (Hylton, 1991), the service quickly expanded and now provides regular service from campus to Boston, East and West Cambridge and Somerville. Ridership on the shuttles have increased from 40,000 monthly riders in 2004 to 79,833 in 2014 (MIT Parking and Transportation Office, 2014). The shuttles are periodically re-calibrated to ensure that they have stops close to off-campus student residences and run their routes on-time and at a high enough frequency to be highly utilized by employees and students.

4.2.2 CURRENT PARKING AND TRANSIT BEHAVIOR AT MIT
This section examines the current parking and transit behavior of MIT employees. The information was obtained by combining the MBTA records of CharlieCard usage and parking behavior from four of the large parking garages on campus over a period of six months between October 2013 and March 2014. This data, as well as select demographic information provided by the Office of the Provost research team and the Office of Parking and Transportation, allowed for an analysis of the current usage of parking garages by those who pay for regular parking permits, occasional parking permits and other types of permits, as well as those who have a monthly transit pass or a Mobility Pass or neither.

All employees who have parking through MIT have a chip in their MIT ID card that can be used to access gated parking garages and lots. In addition to parking access, some employees have CharlieCard chips in their MIT card if they are participants in the Mobility Pass experiment, or they have a separate
monthly pass CharlieCard distributed by the Parking and Transportation Office when they purchase a transit pass. Unfortunately, when the monthly pass CharlieCards are distributed, it is not noted to which employee they were distributed. Because there is no connection between the CharlieCard number and the MIT ID, these cards cannot be tracked back to the commuting behavior of individual MIT employees unless the employee volunteers to provide MIT with their CharlieCard number. In the 2014 MIT Commuter Survey, approximately 1300 employees provided their CharlieCard number to the research team and their transit behavior can be tracked alongside their parking usage. Unfortunately due to unclear instructions, many members of the MIT community did not provide valid numbers and could not be tracked. Only 200 surveyed employees volunteered their card numbers and had transit trips in the MBTA data.

A breakdown of MIT employee parkers can be seen in Figure 4-6 below, with 47% of parkers paying $1,455 per year ($121.25 per month) to park an unlimited number of days on campus as an annual parker. The occasional parkers make up the next largest group with 42% of parkers paying $81 per year and $7.70 per day to park at MIT. While there used to be a cap on the number of days an occasional parker could park on campus per month (8 days), this cap was lifted in the early 2010s. The remaining parkers represent 11% of the total non-student parkers on campus and are associated with either carpools, vanpools, department vehicles, campus resident, volunteer or contractor. Overall there are 21 different types of parking categories for MIT employees, residents, affiliates, and students.

![Figure 4-6: Non-Student MIT Parkers, 2014 (4,787 Total)](image)

When making the decision whether or not to purchase an annual parking pass, rational employees might consider the costs of alternatives, such as the purchase of an occasional parking pass, or an occasional parking pass and a monthly transit pass (LinkPass). In Figure 4-7 below, the costs of these three alternatives are compared on a monthly basis. As seen in the figure, the breakeven point between purchasing an annual parking pass and purchasing an occasional parking alone is parking between 14 and 15 days per month. The breakeven point between purchasing an annual pass and an occasional pass with a monthly transit pass is parking 10 days per month.
According to analysis performed on current parking usage, the average annual parker parks 14 days per month- less than the breakeven point for choosing between an occasional and an annual parking pass. This result suggests that approximately half of the employees who choose to spend $121.25 per month on a parking pass are paying more than they would if they switched to occasional parking. This analysis will be discussed in further detail later in this chapter.

In the fall of 2014, the MIT Parking and Transportation Office calculated the number of new parking permits issued and their associated revenue and estimated that for parking permits (both primary and for each additional vehicle), they expect $4.5 million in payroll/bursar deductions. This estimate does not include the day-rate charged for occasional parkers each time they park, nor does it include parking permits distributed to contractors, department vehicles, non-employee or volunteer revenue.

The office also calculates the cost of providing parking on campus on a per-parker basis. The cost of providing parking (including building new garages, maintenance on current garages, gate hardware and software, salaries of the parking office employees, etc.) for the 2014-2015 year was $3,439 per parking space. As seen in Figure 4-8, the total value of each column is the cost per parking space of providing parking on campus each year. The total cost of providing spaces on campus continues to rise and fall as new spaces in new garages are added and major maintenance is performed on older garages. The blue portion of the column shows the amount each annual parker pays to park. Over time, this parking fee has increased from $575 in 2005 to $1,455 in 2014. The orange portion of the column represents the subsidy MIT provides each annual parker. The percentage shown above the amount of the subsidy is the percentage of the total cost of parking on campus paid for by MIT. One goal of the parking office over the past decade has been to bring the parking subsidy down to 50% of the cost of providing parking to MIT employees. A 50% subsidy would match the percentage subsidy provided to transit pass users and would more equitably distribute subsidy between parkers and transit riders.
Figure 4-9 below shows the annual subsidy provided by type of parking permit or transit pass. The “Zones” shown are the zones of the commuter rail lines, which MIT subsidizes at 50% of the MBTA monthly rates. The orange bar shows the current subsidy for annual parkers. As indicated in the figure, although the subsidy for annual parkers has decreased 6% from 2010-2011, it is still almost four and a half times the subsidy MIT provides its LinkPass (all bus and subway) users. This suggests that parking is more highly valued on campus than transit usage. There is only one commuter rail zone (Zone 9) that has a higher subsidy than that of annual parkers, but in 2014, only two employees purchased a Zone 9 pass each month and 79 purchased a Zone 8 pass, while 2,582 people purchased annual parking permits.
A profile of the type of employees who purchase annual parking permits can be seen in Figure 4-11 on the proceeding page. As compared to their portion of the entire employee population (Figure 4-10), a larger percentage of faculty (45.5%) and administrative staff (39%) purchase annual parking permits. The group that makes up the largest portion of the employee population, the “Other Academic Group,” which refers to post-docs and many part time staff, makes up 36% of the total employee population but only 9% of the annual parkers.
In order to assess parking on MIT campus and compare that usage to transit usage by the same sample of employees, a series of steps was followed to determine an accurate usage rate for different types of parking permit holders. As previously mentioned, annual parkers park on-campus an average of 14 days per month. This value was determined through the following methodology:

1. Collect six months of parking gate tap ins and tap outs for four garages on campus
2. Remove all "Tap Outs" from sample (each parker should have one tap in and one tap out each day and therefore in order to count the number of parkers we need only one of these two data points)
3. Remove all duplicate entries per user per day (each user is charged per day of parking, even if they leave and come back midday, or if they tap into multiple garages due to a meeting on the opposite side of campus)
4. Remove invalid entries and error messages
5. Remove weekends when parking on campus is free
6. Acquire the list of employee MIT IDs assigned to park in the four garages for which you have data
7. Sample the population and determine if low parking usage values are legitimate through a review of individual files in the Parking and Transportation employee database (such as the permit holder is a maintenance person who must drive his/her tools from lot to lot but once in a while parks in the sampled garage)
8. Remove those parkers whose primary garage was not in the four garage sample but who parked in the sample garages a small number of times during the study period (their
parking utilization should be measured overall on campus and will unintentionally reduce the average number of days parked if they are left in the sample)

9. Analyze the type of parkers present in the garage and patterns in their parking behavior

As seen in Table 4-1 below, the average number of days parked for annual parkers varies from 1.3% of the population parking 1-2 days per month, to the same percentage parking 19-20 days per month. Employees occasionally work from home, take vacation days, take a bicycle to work on a pleasant weather day or have a number of other reasons for getting to work outside of their car. With 13 official MIT holidays for employees, as well as portions of the year where naturally fewer people park on campus (December holiday vacations, January break from academic classes, the summer months, etc.), it is reasonable that many annual parkers could pay less by switching to occasional parking permits due to the number of days they are not required on campus each month.

**TABLE 4-1: AVERAGE NUMBER OF DAYS PARKED PER MONTH BY ANNUAL PARKERS (OCT '13-MAR '14)**

<table>
<thead>
<tr>
<th>Avg Days Parked per month</th>
<th>Scaled Number of Annual Parking Permit Employees</th>
<th>Percentage of Total Annual Parking Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;20</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>&gt;21-22</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>&gt;23-24</td>
<td>33</td>
<td>1.3%</td>
</tr>
<tr>
<td>&gt;25-26</td>
<td>26</td>
<td>1.0%</td>
</tr>
<tr>
<td>&gt;27-28</td>
<td>31</td>
<td>1.2%</td>
</tr>
<tr>
<td>&gt;29-30</td>
<td>25</td>
<td>1.0%</td>
</tr>
<tr>
<td>&gt;31-32</td>
<td>46</td>
<td>1.8%</td>
</tr>
<tr>
<td>&gt;33-34</td>
<td>56</td>
<td>2.2%</td>
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<td>&gt;35-36</td>
<td>81</td>
<td>3.1%</td>
</tr>
<tr>
<td>&gt;37-38</td>
<td>91</td>
<td>3.5%</td>
</tr>
<tr>
<td>&gt;39-40</td>
<td>107</td>
<td>4.1%</td>
</tr>
<tr>
<td>&gt;41-42</td>
<td>100</td>
<td>3.9%</td>
</tr>
<tr>
<td>&gt;43-44</td>
<td>104</td>
<td>4.0%</td>
</tr>
<tr>
<td>&gt;45-46</td>
<td>166</td>
<td>6.4%</td>
</tr>
<tr>
<td>&gt;47-48</td>
<td>178</td>
<td>6.9%</td>
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<tr>
<td>&gt;49-50</td>
<td>226</td>
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<td>&gt;51-52</td>
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<td>&gt;53-54</td>
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<td>&gt;55-56</td>
<td>394</td>
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<td>189</td>
<td>7.3%</td>
</tr>
<tr>
<td>&gt;59-60</td>
<td>33</td>
<td>1.3%</td>
</tr>
</tbody>
</table>
Occasional parking permit holders drive many fewer days to campus on average per month. Comparing the distribution of average days parked per month for occasional parkers that also purchase an MBTA LinkPass versus those that do not have a transit pass, the average days parked per month varies from a mean of 2.7 days to 3.2 days as seen in Figure 4-12 below. Many more occasional parkers do not purchase a LinkPass than do, but those who do, park less often. The “No Transit” category represents those occasional parkers who do not have any type of transit pass through MIT. This information along with parking data associated to annual parkers informs the financial model discussed in Chapter 5.

![Figure 4-12: Distribution of Average Days Parked Per Month for Occasional Parkers, Oct '13-Mar '14](image)

Comparing employee home locations for the holder of different types of parking and transit passes distributions provides further insight on parking habits. The map below (Figure 4-13) shows the proportion of annual and occasional (with and without Linkpasses) parkers within zip code tabulation areas (ZCTAs) in the Boston metropolitan area. The relative size of the circle for each ZCTA represents the number of MIT campus parkers who live in that zip code and fall into one of those three categories. Generally, the further from campus, the higher the percentage of annual parkers and the lower the absolute number of employees who park. The zip codes that have a large proportion of occasional parkers with LinkPasses are the areas that should be targeted for potential shifts from the annual and occasional parker without LinkPass populations to greater transit, bike and walk use. It is in these locations that the annual and occasional parkers have viable transit alternatives because if other employees nearby are choosing to buy monthly transit passes, there must be reasonable transit alternatives available. The areas where very few people purchase transit, such as along the Mass Pike (I-90) and outside of I-495, should be considered for vanpool and carpool incentives, but do not have easy access to transit so they may not benefit from the introduction of a highly subsidized transit pass.
MIT employees who have both a transit pass and a parking pass are distributed throughout the greater Boston area as seen in Figure 4-14 on the following page. The largest populations of dual pass holders live along the major MBTA rail lines (particularly the Red Line). Clearly the further from campus, the fewer people have both a monthly pass and a parking pass, but there are many people who live along commuter rail lines on the North and South Shores who occasionally drive but are also interested in taking public transit to commute to MIT.
FIGURE 4.4: MIT EMPLOYEES WHO HAVE BOTH TRANSIT AND PARKING PASSES THROUGHOUT
Figure 4-15 shows a breakdown of MIT employees which include all parking and transit pass types (including employees who have no parking or pass through MIT). The closer to campus, the larger the proportion of employees who do not pay for a parking or transit pass. These employees most likely walk or bicycle to campus each day and most likely cannot justify paying for a transit pass at $37.50 per month (the cost of a monthly pass after the 50% MIT subsidy) because they spend less than that on MBTA trips each month. This segment of employees is currently receiving no transportation benefits from MIT (unless they participate in the pre-tax bicycle income set-aside at $20/month). From an equity perspective, walkers and bicyclists are excluded from approximately $400 to $2000 of subsidy each year that could be paid for by the Institute. This group is more likely to participate in transportation benefits if they were more highly subsidized, or if a transportation benefit cash-out were offered. If all employees were offered a bonus for not parking on campus, more employees might consider active modes of commuting.
**Current Total Parking Lot Utilization**

There is always concern about parking capacity in an urban environment with a growing employee base. MIT is in the process of designing new underground parking garages for employees in the Kendall Square area to accommodate future perceived demand for parking in that portion of campus. In order to ensure that the research team had an accurate understanding of parking space utilization currently, a count was performed of cars parked in most of the garages and lots on campus. Of the 4,126 active spaces in 53 lots, research assistants in the MIT Transit Lab counted 3,497 (85%) of the available spaces and found a 78% peak occupancy rate campus-wide. Among larger garages, roofs were empty or close to empty and the most centrally-located, underground garage on campus (Stata Garage) had an 84% peak occupancy, which was lower than expected.

The smaller surface lots closest to 77 Massachusetts Ave, those lots easily visible from Kendall Square, and the Westgate lot were the most utilized. The Westgate Lot and the Visitor Lot were both over 100% utilized with illegal parking occurring in these lots. Considering that there were lots with spaces close to Westgate (the W91/W92/W98 lots), the MIT Parking Office should consider adding electronic gates to more lots on West Campus so that daily rate (occasional) parkers can park in those lots as well.

Of the 629 uncounted spaces, about 50% were off-campus in leased spaces such that it could not be determined which vehicles belonged to MIT and which did not, and others were on-street parking spaces or very small lots. In the fullest lots and garages, many of the empty spaces were reserved for handicapped or other designated parkers. It was not clear during the count who the non-handicapped reserved spaces were being saved for. Table 4-2 contains the complete list of garages and lots counted and their associated utilizations. A large digital campus map can be accessed from MIT Facilities¹ to associate the table below with their physical location on a map.

---

TABLE 4-2: PARKING SPACE UTILIZATION ON MIT CAMPUS, COLLECTED- 3/11/15, 11 AM

<table>
<thead>
<tr>
<th>Name</th>
<th>Total Spaces</th>
<th>Occupied 11 am 3/11/15</th>
<th>Utilization Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany Garage</td>
<td>415</td>
<td>334</td>
<td>80%</td>
</tr>
<tr>
<td>East Garage</td>
<td>422</td>
<td>348</td>
<td>82%</td>
</tr>
<tr>
<td>Kendall Square Lot</td>
<td>60</td>
<td>46</td>
<td>77%</td>
</tr>
<tr>
<td>N10 Lot</td>
<td>136</td>
<td>117</td>
<td>86%</td>
</tr>
<tr>
<td>Stata Garage</td>
<td>675</td>
<td>569</td>
<td>84%</td>
</tr>
<tr>
<td>West Garage</td>
<td>372</td>
<td>286</td>
<td>77%</td>
</tr>
<tr>
<td>West Lot</td>
<td>134</td>
<td>14</td>
<td>10%</td>
</tr>
<tr>
<td>Westgate Lot</td>
<td>317</td>
<td>335</td>
<td>106%</td>
</tr>
<tr>
<td>158 Mass Ave</td>
<td>51</td>
<td>49</td>
<td>96%</td>
</tr>
<tr>
<td>Amherst &amp; Danforth</td>
<td>46</td>
<td>29</td>
<td>63%</td>
</tr>
<tr>
<td>Amherst Lot (E51)</td>
<td>60</td>
<td>37</td>
<td>62%</td>
</tr>
<tr>
<td>Sloan Lot (Eastgate Res)</td>
<td>49</td>
<td>33</td>
<td>67%</td>
</tr>
<tr>
<td>Ford Lot</td>
<td>22</td>
<td>20</td>
<td>91%</td>
</tr>
<tr>
<td>Hayward Lot Annex</td>
<td>49</td>
<td>46</td>
<td>94%</td>
</tr>
<tr>
<td>Hayward St Lot</td>
<td>193</td>
<td>162</td>
<td>84%</td>
</tr>
<tr>
<td>Kresge Lot</td>
<td>93</td>
<td>61</td>
<td>66%</td>
</tr>
<tr>
<td>Sid-Pac Garage</td>
<td>132</td>
<td>60</td>
<td>45%</td>
</tr>
<tr>
<td>Sid-Pac Lot</td>
<td>75</td>
<td>24</td>
<td>32%</td>
</tr>
<tr>
<td>Visitor Lot</td>
<td>54</td>
<td>55</td>
<td>102%</td>
</tr>
<tr>
<td>W91 Lot</td>
<td>59</td>
<td>40</td>
<td>68%</td>
</tr>
<tr>
<td>W92 Lot</td>
<td>18</td>
<td>12</td>
<td>67%</td>
</tr>
<tr>
<td>W98</td>
<td>65</td>
<td>45</td>
<td>69%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3497</strong></td>
<td><strong>2722</strong></td>
<td><strong>78%</strong></td>
</tr>
</tbody>
</table>

4.2.3 MIT COMMUTER SURVEY RESULTS

Every two years MIT conducts a survey of its entire population (both students and employees) to determine trends in commuting to and from campus. The survey provides a medium to assess any transportation programs currently in place or proposed by the administration. The Office of the Provost has been analyzing the results since 2004.

According to the 2014 biannual commuter survey, 16% of surveyed MIT employees who currently consider driving alone their primary mode are considering changing the way they commute to campus and of those, 73% are considering taking public transportation (MIT, 2014). The MIT commuting survey included a week-long travel diary component that asked respondents to document their commutes to and from MIT each day. Among respondents who said their primary mode was driving alone, 12% took a more sustainable mode one or more times during the travel diary week, two-thirds of which took public transportation. Based on these factors, changes to the cost and accessibility of transit to these employees can increase ridership and revenue for the MBTA. As seen in Figure 4-16 below, more than 16% of survey respondents who were currently using the Mobility Pass used an
alternative commute mode one or more times per week as compared to those who were unaware of the Mobility Pass, only 11% of whom used an alternative commute during the travel diary week (MIT, 2014).

**FIGURE 4-16: COMMUTE BEHAVIOR OF EMPLOYEE DRIVE ALONE COMMUTERS RECORDING 5 DAYS OF TRAVEL**

Among those survey respondents who volunteered their CharlieCard number, 200 provided a valid number and were seen in the MBTA system at least once over an examined six-month time period. Figure 4-17 shows the average transit trips per month for these 200 employees by their primary mode between March and November 2014. The summer months were not included because not all employees are as regular in their commuting patterns outside of the academic calendar and the goal was to measure “typical” conditions for the entire MIT employee population. Clearly the groups that say their primary mode includes public transportation are assumed to have a higher average number of transit trips, but even the group of users who indicate their primary mode is driving alone use their CharlieCard an average of 2.5 to 5.9 trips per month. This confirms that mode shift is possible across all employee groups, not just those who primarily use alternative modes.
Those employees in this sample who walk have very consistent transit trips and vary between 13.7 and 15.6 trips per month, while those who say they walk and then take public transportation vary drastically between 27.9 and 49.4 trips per month. Bicyclists who also take public transportation also vary in a similar way to the Walk, then Public Transportation group, with lower transit use during the spring and higher during the fall. This suggests that the behavior of public transportation users is most dependent on the weather and that the worse the weather, the higher the likelihood of transit trips.

Error! Reference source not found. is an analysis of employee mode share taken from commuting surveys from 2004 through 2014. This analysis, performed by the MIT Office of the Provost, shows each type of employee and their primary mode choice over the past six commuting surveys (MIT Office of the Provost, 2014). Notable trends include a general downward trend of Drive alone mode share across all employee groups, and a general increase in shared rides. Faculty and Administrative Staff have the largest percentages of Drive alone mode share, while Sponsored Research Staff and Other Academic Group employees have the lowest. Over this time period, parking fees have increased 11% per year, which has had a direct effect on the percentage of people who purchase parking permits.
**Mode of Commuting to MIT by Staff Type, 2004-2014**


<table>
<thead>
<tr>
<th>Year</th>
<th>Faculty</th>
<th>Support Staff</th>
<th>Sponsored Research Staff</th>
<th>Other Academic Group</th>
<th>Administrative Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>44%</td>
<td>46%</td>
<td>36%</td>
<td>39%</td>
<td>39%</td>
</tr>
<tr>
<td>2006</td>
<td>21%</td>
<td>20%</td>
<td>36%</td>
<td>39%</td>
<td>34%</td>
</tr>
<tr>
<td>2008</td>
<td>21%</td>
<td>22%</td>
<td>38%</td>
<td>42%</td>
<td>39%</td>
</tr>
<tr>
<td>2010</td>
<td>22%</td>
<td>22%</td>
<td>42%</td>
<td>42%</td>
<td>39%</td>
</tr>
<tr>
<td>2012</td>
<td>22%</td>
<td>22%</td>
<td>42%</td>
<td>42%</td>
<td>39%</td>
</tr>
<tr>
<td>2014</td>
<td>22%</td>
<td>22%</td>
<td>42%</td>
<td>42%</td>
<td>39%</td>
</tr>
</tbody>
</table>

*FIGURE 4-18: MODE OF COMMUTING TO MIT BY STAFF TYPE, 2004-2014 (MIT OFFICE OF THE PROVOST, 2014)*
According to the survey, 84% of MIT employees have flexibility in scheduling their work hours. This suggests that more employees could participate in carpool and vanpool if it was heavily promoted by the administration.

The MIT Commuter Survey is a valuable resource for improvements to commuting programs at MIT and gives employees and students input into the process of determining what aspects of transportation should be prioritized. Employees can recommend options for MIT to consider for future subsidies such as payment of parking fees at MBTA stations. As of the 2014 Commuter Survey, almost 11% of monthly LinkPass and commuter rail pass holders stated they drove alone and then took public transit to work. A small but vocal portion of this population recommended a subsidy for parking at MBTA stations, where parking fees can range from $4 to $7 per day. They stated that they would be more likely to consider the commuter rail or transit in general if they could receive reimbursement for a portion of the parking fee. The MIT Parking and Transportation Office considers each of the requests and assembles estimates of cost to MIT for improvements to the commuter benefits for review by the Executive Vice President. For an outline of recommended incentives and benefits for MIT to pursue based on the commuter survey, financial analysis, and research into commuting behavior change, see Chapter 5.

4.2.4 MIT MOBILITY PASS PILOT PROGRAM

Beginning in 2010, MIT initiated a mobility pass pilot program with the MBTA. The university distributed MIT ID cards to a group of employees and all students that contain a CharlieCard chip inside. The employee ID cards were activated as a free transit card for the MBTA that were distributed to those who pay to park everyday on campus. The intent was to incentivize drivers to consider occasionally switching to transit instead of taking their own vehicles to work at MIT, bringing the marginal cost of taking transit down to zero. The student IDs were set up as stored value cards that encourage MIT students to travel throughout Boston using transit. This design promotes public transit by removing any barriers to entry: the students and faculty have access to the MBTA without needing to purchase a separate CharlieCard from a series of inaccessible locations.

A 2004 MIT master’s thesis examined universal passes and proposed the pilot program which was implemented for MIT six years later. In that thesis, Hester emphasized the benefits to the transit agencies: “retention of existing riders, attraction of new riders, increased efficiency of fare media distribution, increased efficiency of fare collection, and increased support from the business community and general public” (Hester, 2004). The MBTA agreed to the pilot and in 2014, four years after the program began, those annual parkers with access to a Mobility Pass were parking 3-4% less than those without a pass and the MBTA received additional revenue for each of those previously-untaken rides.

The Mobility Pass currently costs MIT approximately $6,400 per month in pay-per-use fares. Of the total employees who have an annual parking pass and have the Mobility Pass in their MIT ID, transit trips per month average between 1.19 and 1.66 per month. Of those annual parkers, those who use
the built-in CharlieCard take between 2.9 and 4 transit trips per month. Occasional parkers use their built-in CharlieCard more often than annual parkers. Occasional parkers who use their card take between 4.27 and 5.55 trips per month, while of the total population with a chip in their card, they take between 1.89 and 2.46 trips per month. This usage makes sense as annual parkers have pre-paid for their parking on campus, while occasional parkers make a daily decision between $7.70 to park on campus or a free transit trip.

An analysis of parking usage over six months (October 2013 to March 2014) as a result of the Mobility Pass trial shows that the annual parkers with a Mobility Pass parked an average of 13.17 days per month, while the annual parkers with no Mobility Pass parked 14.25 days per month. These values were calculated by including those parkers who had a CharlieCard in their ID and were seen at least once during the study period in one of the sample four garages on campus. There are drawbacks to using this approach to calculating parking usage as it includes those Mobility Pass users who park outside of the sample garages most of the time but parked in the sample garages at least one time over the study period. This behavior will reduce the overall average of parking usage. Fortunately this potential error affects both parkers with a Mobility Pass and those without a pass similarly and therefore we can assume that the difference between the two groups is still valid.

The Mobility Pass pilot had some limitations in implementation and management. The program was opt-in, meaning that each employee with an annual parking permit who wished to participate could sign up to receive a free transit pass. This could artificially inflate the potential extent of estimated behavior change because employees who were already interested in participating were the ones who signed up for a pass, while those who do not wish to use transit did not participate. Additionally, the pilot was not well advertised or combined with any sort of feedback program to allow experimenters to immediately examine the results of the implementation or include comments or responses (beyond anecdotally) from participants.

Approximately 70% of the 2014 employee commuter survey respondents were not aware of the Mobility Pass pilot program (MIT, 2014). It was suggested that further advertising of the program among those who were issued a Mobility Pass and the community at large could improve the results of the trial. Expanding the program to the entire MIT employee population would allow further testing of its effectiveness and viability in the Boston market. Based on the current results, simply expanding the Mobility Pass to all annual parking permit holders could save MIT 100 spaces if the entire population of parkers had access to free transit. Even without additional incentives, this could significantly reduce the future demand for building new parking garages on campus and potentially allow older garages to be converted to usable housing, research and learning space.

With the current 11% increase in parking fees per year at MIT, annual parkers have responded to the price increase by steadily switching to occasional parking permits. As the price of an annual permit increases by 10%, the number of annual parking permit holders decreased by 1.04% each year. The relationship between the cost of the annual permit and the number of annual parkers has an elasticity of -0.104. This suggests that by continuing to increase the price of a parking permit, employees will make different commuting choices.
4.3 **Summary of TDM in Cambridge and MIT**

This chapter highlighted TDM programs and trends in Cambridge, as well as described current commuting and parking behavior of MIT employees. The chapter included lessons learned from other cities on providing universal passes and parking cash-out options to large employers. The MIT Mobility Pass trial from 2010 to present resulted in a 4% reduction in parking on campus among annual parkers and a significant increase in transit usage by participants. The next chapter, Chapter 5, includes recommendations for commuting incentives to be used at MIT and other large employers as well as a methodology for implementation.
5. PROPOSED INCENTIVES AND METHODOLOGY FOR EXPERIMENT

This chapter includes the criteria for choosing incentives to be considered for different types of employers, the proposed incentives to be used in this experiment, and a methodology for putting the experiment in place at MIT and other Kendall Square employers. This methodology includes a financial model of the costs of implementation at MIT and the underlying assumptions of that model. This chapter continues with several proposed options for implementing an expanded Mobility Pass and the costs associated with different experiment implementation scenarios at MIT. The chapter concludes with a description of incentives to use at MIT and a list of other employers to pursue, as well as recommendations for the types of incentives to propose to the additional employers.

5.1 CRITERIA FOR CHOOSING INCENTIVES

The following section contains descriptions of factors that could affect the effectiveness of particular commuting incentives. These factors provide the criteria for choosing appropriate incentives for commuting behavior change and include the current commuting behavior of employees at the organization, the size of the institution, the type of marketing campaign, the geographic location of participants, and the proximity/location of alternatives.

5.1.1. CURRENT COMMUTING BEHAVIOR (MODE SHARE)

Current commuting behavior and mode splits can affect the types of incentives that should be implemented in order to maximize commuting behavior change. Employers that have low current transit mode share and high SOV rates can consider different incentives than those that already have a higher alternative mode share. As discussed in Chapter 3, companies in Minneapolis with high transit mode shares saw the largest increases in transit mode share with the introduction of a universal pass. Although the universal pass should improve the transit mode share of all urban organizations, an organization with a high transit share will see a larger benefit from the pass than a lower mode share. The transit mode share for the Kendall area was already high at 25.6% as of 2013 (higher than the SOV share of 22.7%). Businesses in Kendall Square with a large percentage of employees who commute by transit would more likely see a larger improvement from universal transit passes than employers with a lower transit mode share due to the fact that these businesses are already primed for transit universality.

According to Andrea Hamre and Ralph Buehler (Hamre & Buehler, 2014), those organizations that offer free parking alongside other transportation benefits (even if those benefits include free transit) will have a very high SOV mode share. Organizations in the Kendall Square area that provide free parking to their employees (such as the Volpe Center) should be the targets of parking cash-out programs. According to their calculations, “free car parking alone is associated with a 96.6 percent probability to drive alone to work—an increase of about 20 percentage points compared to when no
benefits are provided.” They found that even under the scenario where free parking is combined with public transportation benefits, and biking/walking benefits, the probability of driving alone was 86.8 percent. Parking cash-out, partial cash-out, or considering a parking charge for those organizations that have a higher Drive Alone rate are more effective incentives to change mode share for low transit share organizations. It is important to keep in mind the current commuting behavior and mode share of an employer when proposing the most appropriate incentives for behavior change.

5.1.2. SIZE OF INSTITUTION
The size of the institution can affect the types of incentives that can be implemented and the effectiveness of those incentives. For example, small organizations have a smaller community to choose from when forming carpools and may not have the capacity to offer its employees vanpool services. Additionally, they do not generally have the ability to negotiate special contracts with transit agencies (such as the MIT Mobility Pass Pilot or the proposed MBTA College Pass) because they do not represent a large number of employees or potential transit riders. However, small organizations may be better equipped to provide full transit subsidies to their employees because it is not very costly to the organization if 20-30 employees receive a $75 per month (1500 to 2250 per month) transit benefit as opposed to providing the same benefit to all MIT employees (more than 600,000 per month). On a per-capita basis, the cost is the same for both small and large organizations, but large organizations are less likely to participate because the start-up costs are a seemingly insurmountable obstacle to large organizations who may balk at a $1 million expense.

Smaller organizations can have more direct influence over their employees because they can speak personally with each participant who has transportation benefits. However, they may not have the appropriate human resources or finance staff in place to offer pre-tax benefits through their payroll system or they may not have the personnel to focus their efforts on getting their employees to commute efficiently. Large employers may have the staff but not the ability to provide each individual employee with a customized commuting plan that can be done more easily with smaller organizations.

Large employers should focus their commute incentives on large-scale initiatives such as introducing a pay-per-use universal pass, providing a commuter dashboard that contains social “nudges” comparing peer’s commuting activities and emphasizing carpool and vanpool formation. MIT with its over 8,000 employees represents more than 10% of the total annual memberships for Hubway the bikeshare network, and therefore they have more influence over future city-wide bikeshare policies and procedures. Small employers should focus on office-wide initiatives that can be implemented effectively on a smaller scale such as Walk or Bike to Work events and providing subsidized monthly transit passes to employees. Walk or Bike to Work events may be more successful in Kendall Square because a large proportion of employees (over 50% of MIT employees) live within five miles of Kendall Square.

Parking cash-out (or partial cash-out) can be implemented by both large and small organizations, but the larger the organization, the less the administration is willing to pay for cash-out programs because of their larger perceived cost to the organization and because it is more difficult to track the usage of the spaces while predicting future demand. Additionally, the larger the employer, the more likely the
employer is to own the majority of its parking facilities rather than lease spaces for their employees. For example, if a company has 50 employees who park in spaces leased from their building manager, they can offer employees the cost of leasing one space upfront and then have the employee pay to park each day in the space. The employer can track parking usage easily because there are fewer spaces of which to keep track. Any spaces that are not used consistently can be written out of the next lease agreement with the property owner and directly save the employer money on parking. In the case of a large employer like MIT, almost all of the parking garages are owned by the Institute while only 267 spaces are leased from other parking facility owners. Parking cash-out would cost a great deal more to implement due to the size of the institution and tracking the resulting parking usage would be more difficult. Because MIT owns most of the parking spaces, the monetary savings from a cash-out would be the ability to retire garages over time to create more space for other types of real estate usage and it is more difficult to predict the ultimate savings from implementing the cash-out program over time.

Another alternative is to consider a regulatory change to large organizations to allow their parking facilities to charge a daily fee and open the garages up to the public market.

5.1.3. Marketing Campaign

Some incentives could be more effective than others depending on the extent of marketing ability organizations have. The more complex the design or the larger the impact the incentive may have, the more attention must be paid from a marketing perspective in order to ensure success. Organizations that have staff in place to commit to implementing more large-scale efforts should consider more complex incentives. For example, joining the MBTA corporate program does not require a large effort on the part of the employer. The process for joining the program and distributing monthly transit passes is well-established and does not require any creative solutions on the part of an organization. However, implementing an employer-specific commuter dashboard involves a significant investment in time and budget to assemble custom data sources such as parking data, connections to the MBTA CharlieCard system, and collecting mobile application usernames and passwords, as well as heavily marketing the dashboard within the employee community in order to be effective. Based on the effectiveness of the Stanford University dashboard (Zhu, et al., 2015), for those organizations who are willing to devote the effort, the commuter dashboard may be an excellent “nudge” towards alternative commuting. For a description of the design of the commuter dashboard for an MIT implementation, refer to Chapter 6. Without the effort towards marketing, the dashboard incentive will not be as effective as desired and probably should not be pursued.

Organizations that cannot assemble a team to work on commuting options and marketing should consider incentives that are run by other organizations such as the MBTA corporate pass, a corporate Hubway account, or joining a local transportation management association. In each of these cases, the employer can rely upon the expertise and management of others to run marketing campaigns for incentives such as the Charles River TMA marketing the EZ Ride shuttle and vRide vanpool services to its members. Companies can receive the benefits of having incentives in place without devoting their own resources to managing custom marketing campaigns.
5.1.4. **Geographic location of participants**
Participants that live far from an organization and participants who live close respond differently to different types of incentives. Recommending enhancing bicycle infrastructure or adding commuter shower facilities may appeal to employees who live within biking distance of their employer, but will not reduce SOV mode share among those who live further from campus. Similarly, incentives focused on carpooling/vanpooling will not change the behavior of those who live within 2-3 miles of work. Similarly, offering commuter rail or transit passes to people who do not live near a rail line will not change the number of people who take the train unless that incentive also includes subsidized parking at the rail stations to promote driving to transit as an alternative.

Incentives should be offered in packages to appeal to the largest number of employees possible without excluding certain groups based on geographic location.

5.1.5. **Built environment - location of parking/proximity of alternatives**
Employers with parking lots in or very near their buildings, or those that are located far from rail stations, bus stops or safe bicycling/walking routes are less likely to express an interest in reducing SOV mode share. In these cases, regulations can help persuade employers to participate in programs, but in the absence of regulation employees may respond to different types of incentives depending on the ease with which they can use alternative modes. For example, for employers located in suburban areas without sidewalks or bike paths and with large parking lots close to the buildings, incentives such as parking cash-out (plus adding a parking fee in areas that have free parking currently) and emphasizing carpool/vanpool creation where carpoolers receive preferential parking and are charged a lower parking fee than SOV drivers may inspire behavior change. These same employers may not respond well to commuter dashboard information focused on their commutes as the variety of alternatives available to them would be low.

For urban employers located near rail stations, promoting an inexpensive universal transit pass and providing bicycle and walking facilities (racks and on-site showers) will be more likely to influence commuting behavior than carpool formation efforts. Additionally, a commuter dashboard highlighting all of the alternative modes commuters can utilize and comparing them to their peers’ and their neighbors’ mode choices may impact their SOV mode share.

Each factor or aspect of an organization described above should be considered when choosing which incentives should be offered as part of a package to employers.

5.2  **Proposed incentives to be used in this experiment**
Kendall Square is an urban center within the Boston region with excellent transit access and as a result, many innovative large companies and organizations have offices in the area. The following is a list of incentives that should be offered to employers in the Kendall Square area and particular details of the implementation process. These recommendations apply to MBTA policies surrounding changes to the corporate pass program, the implementation of employer-specific commuter dashboards (see Chapter 6), partial parking cash-out options, daily parking rates, and lotteries for participation in the program. The list of incentives below can be chosen separately, or in combination by Kendall Square
employers who would like to participate in the experiment. The combination of incentives proposed to be used at MIT in particular is described in section 5.3 later in this chapter.

5.2.1. EXPANDED UNIVERSAL PASS
For a high transit mode share area like Kendall, bringing a pay-per-use universal pass program to the MBTA would increase transit ridership and promote alternative commutes for new employees of large organizations. According to the 1999 Portland study, the TriMet universal pass program “produce[s] a greater increase in transit ridership” than the TriMet monthly pass program. (ICF Consulting, 2005, p. 57) If the MBTA implements a full-scale version of the universal pass with an opt-out policy, they could see similar increases in transit ridership and potentially additional revenues. The following sections outline aspects of the proposed Mobility Pass design for implementation in the larger Boston region.

WORK ONLY WITH EMPLOYERS WHO SUBSIDIZE MORE THAN 30% OF MONTHLY TRANSIT PASSES
The MBTA wishes to work with employers who are already interested in providing transit benefits to their employees. These employers are the most interested in changing mode share and are already invested in transit subsidies that assist in their employee’s commutes. As is the case with the ORCA Business Passport in Seattle, the MBTA Mobility Pass should only be available to employers who are willing to pay a portion of the cost of transit passes because they want to compete for the best employees through excellent benefits or they are facing expensive parking constraints. This is due to the fact that the MBTA already has a successful monthly pass program that makes money for the T due to the fact that many employees who pay for an employer-subsidized pass take fewer trips per month than the total cost of the pass. The MBTA wishes to maintain its current revenue stream, and this requires working with employers who already subsidize passes.

PAY-PER-USE ABOVE A BASELINE LINKPASS PURCHASE
One of the concerns of the MBTA leadership was the loss of revenue resulting from transitioning monthly pass holders who use their pass less than the value of $75/month to pay-per-use, where the MBTA would only receive payment for rides taken. The current usage for some of those riders is less than the cost of purchasing a monthly pass and the MBTA is counting on maintaining all existing revenue streams. Riders pay for the convenience of an unlimited pass even if they do not utilize the full amount because they never need to think about filling their card with stored value or worrying that they have run out of funds. It gives these riders peace of mind, just like employees who pay for an annual parking pass even if their usage suggests that they would save money if they paid for parking daily. In order to maintain current revenue levels for the MBTA, the proposed Mobility Pass Corporate program option should charge the employers the full price of a monthly pass for the current number of employees who have subscribed to the monthly pass plus the cost of all additional rides for all other employees receiving a Mobility Pass.
For example, if a company currently has 100 employees and 50 employees pay for the monthly pass through their company, the MBTA receives $3,750 per month from this company. If the company then offers a universal Mobility Pass to all 100 employees, the company would pay a minimum of $3,750 per month to the T, plus the rides of any 50 additional employees designated to receive the pay-per-use Mobility Pass.

As a company grows, so too would the percentage of people who would be monthly pass holders if not for the universal Mobility Pass. Therefore, the minimum fee to the MBTA would increase proportionally. In the previous example, if the company were to grow from 100 to 150 employees, the minimum fee would increase from 50 employees $X$ $75$/month = $3,750$/month to 75 employees $X$ $75$/month = $5,625$/month. The MBTA can perform an assessment of the transit usage of companies’ employees before the program is implemented by collecting the CharlieCard numbers of employees who currently use the T, and incrementally after implementation to determine if an adjustment to the minimum fee structure should be made.

**Add a Nominal Administrative Fee per Card Issued to Enhance MBTA Corporate Pass Program**

The MBTA’s corporate pass program web portal is outdated and in need of additional functionality both to continue operating effectively for its current purpose and to accommodate a new universal pass. By charging employers a nominal fee of $1 per card for administration costs, the MBTA can raise the money it needs to improve the web portal for the benefit of employers and the T. They can also use these funds to support the creation of an Employer Advisory Committee consisting of participating companies to identify common issues and suggest future improvements to the MBTA corporate program.

**New MBTA Employer Portal**

The MBTA employer portal currently allows transportation coordinators to order batches of different types of CharlieCards for distribution on-site. A portal that allows for usage tracking, new employer sign-ins and information, monthly billing statements and electronic payment transfers from participating employers would be a great improvement for both the MBTA and the employers. Improvements to the portal would reduce administrative overhead costs and provide businesses with insight into their employee’s aggregate commuting behavior as well as an improved connection with the transit agency. Based on discussions with T management, a modest IT staff increase would be required to implement the portal.

**New Billing Process**

In the general case, transit agencies such as the MBTA are likely to have lots of inertia in changing software and, using the proposed administrative fee discussed above, the MBTA can include usage information and monthly bills for each employer on the corporate pass web portal. According to Dominick Tribone at the T, it is a straightforward process to automate the billing process by improving a few steps to the process of accurately assembling a monthly bill for each employer (Tribone, Dominick & Salvucci, Frederick, 2014). This will make the extended pilot much easier to
expand network-wide when the time comes to make the universal pass permanent and available to all employers.

**NEW CARD DISTRIBUTION AND EMPLOYEE ID CARD INTEGRATION PROCESS**

Integrating fare payment chips into employee ID cards "offers the potential to reduce agency-issued card costs and associated eligibility determination processes." (Kocur, 2010) The MBTA can benefit from scaling back their role in the card distribution process when it comes to large employers. MIT already has employee and student IDs that contain a Charlie chip and more employers should have the opportunity to integrate a transit chip into their IDs that contain parking and building access already. Additionally, the chips should be managed through the web portal to allow for an employee ID to be reprogrammed each month with a different pass type. Currently, in order to switch from a stored value card to a monthly pass, an employee must return their card and receive another card. This process should be performed electronically by individual employers. The SmarTrip card in Washington, DC allows this type of change through their website and the MBTA should follow suit.

**CREATE INTUITIVE SIGN-UP AND MARKETING CAMPAIGN FOR NEW EMPLOYERS**

As previously discussed in Chapter 4, approximately 70% of the MIT employee commuter survey respondents were not aware of the Mobility Pass pilot. This is can be attributed to a lack of concentrated effort on marketing the initiative. In order to increase the number of participating employers and reduce administrative costs, the MBTA needs to streamline their sign-up process to reduce the amount of time each new employer must spend negotiating and planning with an MBTA employee to get started with a universal pass. A clear and clever marketing campaign that motivates employees and employers to change their commuting benefits will increase exposure of the larger pilot program and expanding the program would allow further testing of its effectiveness and viability in the Boston market.

**5.2.2. DAILY PARKING RATES**

As discussed in Chapter 3, daily parking rates are more effective at translating the cost of driving each day to the employee than monthly parking rates. As long as all parking spaces associated to an organization are behind a pay gate (or some other method of measuring daily usage), daily rates can be implemented at any employer. Tracking the number of times parked per month will allow employees to decide each day if they are willing to pay $8-10 to park on site, or take the train or bike for free. Institutions that do not have gated parking and rely on permit stickers and random daily compliance checks and ticketing to ensure parking compliance are not good candidates for daily parking rates.

**5.2.3. PARKING CASH-OUT**

When offering parking cash-out, or partial parking cash-out, employers must have a system in place to support this incentive both financially and technologically. Parking cash-outs are a benefit that supplements individual employee’s income and should be applied to employee’s paychecks as taxable funds. As discussed in Chapter 3, the Commute Club at Stanford provides employees who do not pay for a parking permit the opportunity to earn an additional $300 per year in income as a partial cash-
A similar program can be introduced to employers in the Kendall Square area for those who choose not to park.

This incentive has the potential to be especially valuable as a stand-alone program to companies that have recently moved to the area to establish a new incentive scheme (such as Pfizer’s new workspace), but is less valuable to those organizations that are already well-established with policies that do not provide specific transportation benefits to those who walk or bicycle to work. From an equity perspective, bicyclists and walkers should receive the same subsidy as their driving or transit-riding co-workers. However, this is most often not possible, just as those employers that provide employees with childcare benefits do not provide those employees who do not have children with a cash-out equivalent. It can be costly to provide employees with a benefit such as a large individual cash-out if they had never had any benefit previously. At MIT, this value would range from $450 to $1,984 per year. Implementing a proper cash-out program at MIT would require that 1,700 bike/walkers who do not currently receive funds from MIT be paid a sum of money for their commutes, resulting in no behavior change and creating a larger expense for commuting at MIT.

A partial cash-out may be more appropriate for an established organization with a large non-SOV mode share like MIT. By providing a small subsidy to all employees, MIT can offer benefits to those that are already choosing alternative modes without spending as much as a full cash-out program. Partial cash-outs can be offered through a pre-tax transit or bicycle benefit (up to $130 or $20 per month, respectively) for those not intending to drive to their worksite. Lotteries are a post-tax method of providing a type of cash-out to employees who were previously receiving no transportation benefit without heavily impacting the transportation benefits budget of an organization. Each employee has the opportunity to participate in the lottery and those who use alternative modes have a higher likelihood of winning prizes.

5.2.4. LOTTERIES AND DASHBOARD

As indicated in the Stanford study (Ng, 2014) and others, lotteries and commuter information can be an effective form of incentive for behavior change. Combined with “gamification” elements and social norm descriptive messaging, a dashboard that provides Kendall Square employees with their commuting patterns over previous weeks may help reduce SOV mode share. Employees have the opportunity to earn credits through bike, walk, carpool, and transit commutes and can “cash in” those credits by spinning a wheel for the chance at a larger sum of cash, or by trading in credits for a smaller sum of cash. The rationale and potential alternative designs of the lottery portion of the dashboard is outlined in Fangping Lu’s 2015 Master in Engineering thesis.

Through a lottery system, employees that currently walk or bicycle to work can earn credits alongside employees who are shifting their behavior from driving and be entered to win from the same financial source. The CAPRI project at Stanford spent $211,989 on incentives over the course of two and a half years and provided benefits to 4,057 employees, three quarters of whom were drivers originally (Zhu, et al., 2015). A lottery can serve as less expensive alternative for those organizations that are well-established while providing more equitable benefits among bike commuters, walkers, transit riders and drivers.
In order to be considered for this incentive, the organization must already participate in the MBTA Corporate Pass program. Additionally they must have access to their building parking structures and be able to track employee parking behavior without self-reporting data. Companies that do not already have access to these datasets will find the dashboard and lottery system to be lacking in information, which will make the incentive less impactful on mode share.

5.2.5. CRITERIA-INCENTIVES DECISION MATRIX
The table below (Table 5-1) displays the recommended incentives an organization should consider based on the criteria outlined in the table. Organizations can use the decision matrix to determine a list of incentives from which to develop an employee commuter benefits program. For example, if an organization has a high transit mode share and an urban location, they should consider implementing incentives such as a universal pass, daily parking rates, and a commuter dashboard. A “✓+” indicates a highly recommended incentive, while a “✓” indicates a recommended method (but this method could be less effective at behavior change than other methods). The incentives are recommended based on the effectiveness of incentives introduced and measured in Chapters 3 and 4.

TABLE 5-1: CRITERIA-INCENTIVES DECISION MATRIX

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Universal Pass</th>
<th>Parking Cash-out</th>
<th>Daily Parking Rates</th>
<th>Commuter Dashboard</th>
<th>Bike to Work/Small Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit Mode Share</td>
<td>High</td>
<td>✓+</td>
<td>✓</td>
<td>✓+</td>
<td>✓+</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓+</td>
</tr>
<tr>
<td>Size of Organization</td>
<td>Large</td>
<td>✓+</td>
<td>✓</td>
<td>✓+</td>
<td>✓+</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>✓</td>
<td>✓+</td>
<td>✓</td>
<td>✓+</td>
</tr>
<tr>
<td>Marketing Capacity</td>
<td>High</td>
<td>✓+</td>
<td>✓</td>
<td>✓+</td>
<td>✓+</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>✓</td>
<td>✓</td>
<td>✓+</td>
<td>✓+</td>
</tr>
<tr>
<td>Location of Institution</td>
<td>Urban</td>
<td>✓+</td>
<td>✓</td>
<td>✓</td>
<td>✓+</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>✓</td>
<td>✓+</td>
<td>✓</td>
<td>✓+</td>
</tr>
<tr>
<td>Proximity of Alternatives</td>
<td>Nearby</td>
<td>✓+</td>
<td>✓</td>
<td>✓+</td>
<td>✓+</td>
</tr>
<tr>
<td></td>
<td>Far Away</td>
<td>✓</td>
<td>✓</td>
<td>✓+</td>
<td>✓+</td>
</tr>
</tbody>
</table>

5.2.6. STAKEHOLDER CONSIDERATIONS
On the following page is a matrix that shows a broader consideration for the four stakeholders of transportation incentive programs in the Boston area: employers, employees, the MBTA and society as a whole. The table shows the motivations guiding each stakeholder as well as the impacts each major incentive has on the groups. Each stakeholder has a different perspective from which to view these incentives and this is important to keep in mind when forming a transportation benefits incentives package for employers in Kendall Square.
<table>
<thead>
<tr>
<th><strong>Motivations</strong></th>
<th><strong>Universal Transit Pass</strong></th>
<th><strong>Parking Cash-out</strong></th>
<th><strong>Daily Parking Rates</strong></th>
<th><strong>Commuter Dash/ Lottery</strong></th>
<th><strong>Bike to Work/ Small Initiatives</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increasing recruitment appeal</td>
<td>Employers can reduce the amount of parking they provide to their employees by subsidizing transit passes. Employers can choose to pass on a portion of the costs of the transit rides to their employees, or increase the benefits provided to their employees (with pre-tax treatment of the benefits helping to absorb the cost), resulting in better recruitment of talent.</td>
<td>Treating each employee equitably, the employer can distribute the funds they currently spend on parking spaces (the subsidy provided to parkers) to all employees, who can then choose to pay to park or to keep the funds and walk, bicycle or take transit with the money.</td>
<td>Tracking employee parking each day allows employers to know exactly how many parking spaces are required for their employees to park and they can sell excess spaces to the public at a market rate and improve parking options for customers/visitors.</td>
<td>Track the behavior of employees over time and follow trends in employee commuting. Offer small prizes that reduce SOV commutes and parking on site.</td>
<td>For little upfront cost, employers can promote alternatives without large investments in tracking technology or a long-term system of incentives because these are single-time events.</td>
</tr>
<tr>
<td>• Lower parking costs</td>
<td>Subsidized fixed-price transit passes allow the employee to choose between a deeply discounted (or free) commute to work, and a stressful congested car commute. The pre-tax treatment of benefits also reduces transportation costs for employees.</td>
<td>Employees can choose what to do with the cash-out funds and decide whether to spend the money given to them on parking or keep it for other purposes.</td>
<td>Employees only pay for the days they park as opposed to all the days in a month. 40% of current Annual MIT parkers would save money by paying daily parking.</td>
<td>Provides employees the opportunity to win weekly cash prizes and compete against their peers to be the most sustainable.</td>
<td>Employees can use a Bike to Work event to try a new alternative as part of a structured (and fun) event. The social aspect of these events builds a community of like-minded people.</td>
</tr>
<tr>
<td>• Easier “expansion-in-place” possibilities</td>
<td>Expanding the universal pass program increases ridership for the MBTA by expanding the number of employees who choose to take the T instead of driving to work. The pre-tax treatment and employee subsidy increases the relevance of the MBTA.</td>
<td>MBTA could get an increase in transit riders under a parking cash-out because employees can choose between an inexpensive rail or bus fare and a parking space.</td>
<td>Employers moving to daily parking rates can increase MBTA ridership as employees choose between spending $2.10 versus $8-10 to drive daily.</td>
<td>Use the dashboard as a medium to engage with their riders and possibly access demographic and geographic information to help inform their future transit planning.</td>
<td>Active commuting such as bicycling or walking promotes public transportation ridership on the days when the weather is bad.</td>
</tr>
<tr>
<td><strong>Employer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Employee</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MBTA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Society</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Increasing revenue</td>
<td>The more people who ride transit, the less pollution in the air and congestion on the roadways. Universal transit passes promote density around rail stations and can spur economic development</td>
<td>Cash-out promotes sustainable modes by giving the same amount of transportation benefit money to a parker as to a bicyclist, and employees can choose to keep the funds and use transit or ride their bikes.</td>
<td>Employees consider the monetary consequences of driving alone to work. Internalizes the societal externality for each employee.</td>
<td>The dashboard can be used to promote more sustainable lifestyle choices to a larger population.</td>
<td>A community-wide initiative could reduce auto use and the more active commuters, the more economic growth locally.</td>
</tr>
</tbody>
</table>
5.3 METHODOLOGY FOR KENDALL SQUARE EXPERIMENT

The methodology for implementing the Kendall Square value pricing project is described in the sections below. The first subsection outlines the MIT methodology and the second contains a list of other employers to pursue and the recommended incentives that should be considered for each. The process for implementation at MIT included working with the administration to define several possible scenarios for an all-employee implementation, as well as describing an experiment for a sample employee population to test the behavioral assumptions included in the all-employee financial model. The experiment (either all-employee or sample population at MIT and elsewhere) is expected to be performed between September 2015 and March 2016 based on the process described below.

5.3.1. MIT

The Institute maintains a long-standing Parking and Transportation Committee to consider and recommend the future campus transportation policies and pricing for transportation offerings on behalf of the Executive Vice President and Treasurer of MIT. Within the past year, the committee was divided into sub-committees that examine specific aspects of transportation MIT. These sub-committees include: Daily/Differential Parking, Mobility Pass, Transportation Objectives, and Public Policy. The current goals of this committee include:

- Support MIT missions, including commitment to sustainability
- Be mindful of Institute resources (human, physical and financial)
- Support diverse modes of commuting
- Preserve commuter flexibility
- Be respectful of MIT neighbors and host city
- Respond to campus residents’ transportation needs

(MIT Transportation and Parking Committee, 2015)

The committee represents the employee and graduate student commuting populations and they provide feedback on changes to parking or transit policies considered by the administration. The committee recommends parking rates for the upcoming year and proposes and explores new transportation subsidy proposals. The original Mobility Pass pilot project was put in place because the committee recommended that it be done. The first step of implementing a transportation pricing experiment on MIT campus is to develop a proposal with the full support of the committee.

In this case, the committee proposed that changes to parking and transit pricing be introduced to the larger MIT community through focus groups and the MIT Commuter Survey. The results of the survey suggested that a majority of the annual parker population responded positively (76% provided positive comments) to the idea of expanding the Mobility Pass to the entire population (MIT, 2014). With positive results from the commuter survey, focus groups were formed to discuss changes to the parking rate structure and expanding the Mobility Pass.

*FOCUS GROUPS*
The subcommittee on Daily and Differential Parking held two focus groups during the fall of 2014 and winter of 2015 to discuss changes to parking and transit pricing at MIT with parking coordinators and annual parking permit holders. The first focus group included approximately 25 parking coordinators and the second included employees who responded to a broad solicitation from across departments. The goal of the sessions was to get feedback on the current transportation offerings as well as consider the possibility of changing from an annual to a daily parking rate in combination with unlimited rail and bus use for a modest monthly fee (an expanded Mobility Pass). For a copy of the handout distributed during the focus group, see Appendix C. Focus group participants responded positively to the daily rate + transit pass option as long as it did not cost more than an annual parking pass to participate. They also proposed that MIT subsidize parking at MBTA rail stations, further subsidize commuter rail passes, and consider running an employee campus shuttle from select suburban locations.

**FINANCIAL MODEL**

In order to determine the cost of changes to the program, a financial model was developed to be able to assess the impact of expanding access to a less expensive monthly transit pass while charging a higher daily parking rate and transitioning the entire employee population to daily parking. The current costs and revenue associated to parking and transit usage at MIT are outlined in Appendix B, which is the baseline scenario for which changes are made in the proposed scenarios outlined in the next section.

The baseline scenario captures the current parking and transit usage, which were calculated as described in Chapter 4. The scenario shows the current revenue received from each MIT employee who participates in transportation benefits. The LinkPass value for “Flat Fees Transit/month” is equal to $37.50 per month, which is the amount MIT employees pay for a LinkPass while MIT pays $75 per month to the MBTA for these employees to ride the T, which is about the average transit usage for this group based on the bi-annual Commuter Survey. For Occasional Parkers with LinkPass, the usage is set to $37.50 based on the survey. The revenues were calculated by multiplying each population by the flat fees plus the variable daily parking rate times the average parking usage per month.

**PROPOSED SCENARIOS FOR IMPLEMENTATION AND ASSOCIATED COSTS**

An outline of the three proposed all-employee scenarios are described below. For a financial analysis and population breakdown of each scenario, see Appendix B.

**Scenario 1: Status Quo + Extended Mobility Pass**

- Annual parking rates scaled by 10% from where they are now and permit holders receive free unlimited transit trips
- All other groups pay $15 per month for occasional parking and unlimited transit trips
- $8.50 daily parking rate for occasional parkers and all other groups get opportunity to park for same price
- Commuter rail passes (including 10-ride tickets) are reduced by an additional $22.50/month
Scenario 2: Annual Parking Option Maintained (+10%); All others Pay $15/mo.
for Daily Parking & Mobility Pass; Allows Transit, Bike, Walk Opt-Out

- Annual parking rates scaled by 10% from where they are now
  - 40% of annual parkers switch to daily parking group, receive a $15/month parking and transit pass, and park fewer days as a result
  - 60% remain annual parkers with higher average parking usage and a free transit pass
- All other groups pay $15 per month for parking and unlimited transit trips
- $8.50 daily parking rate for all other groups, carpoolers pay $4.25 per day
- Assume 20% of commuter rail pass holders and 20% of LinkPass holders with add on parking for a one-time $200 initiation fee and then have access to occasional parking (at $8.50/day plus $15/month)
- Assume only 50% of bike/walkers will participate
  - 10% of the total bike/walkers will opt-in to a $200 parking initiation fee and then have access to occasional parking on campus (at $8.50/day plus $15/month)
  - 40% of the total bike/walkers will opt-in to $15/month for transit alone
- Commuter rail passes (including 10-ride tickets) are reduced by an additional $22.50/month

Scenario 3: $0 Mobility Pass for All + Rail Subsidy Increase

- All groups pay $0 per month for unlimited transit trips
- $93 per year plus $8.50 daily parking rate for all groups
- Increase Commuter Rail and MBTA subsidy by $25/mo for parking and cost of rail tickets
- Assume 200 people move from annual Parker to commuter rail + occasional parker

Each commuter population will be impacted differently by the proposed scenarios. The commuter populations include:

- Annual parkers – 2,484 employees
- Carpool/Vanpool – 178 employees
- Occasional parkers (with LinkPass) – 624 employees
- Occasional parkers (without LinkPass) – 1,732 employees
- LinkPass – 3,113 employees
- Commuter Rail – 848 employees
- Bike/Walk – 1,700 employees

In Scenario 1, all groups remain the same size, while annual parkers pay more for their parking each month. Scenario 2 assumes that 40% of annual parkers will switch to daily parking rates, 20% of LinkPass and Commuter Rail users and 10% of bike/walkers will add occasional parking, and that 40% of bike/walkers will opt-in to a transit-only Mobility Pass for $15 per month. Scenario 3 proposes that all groups remain the same size but that each pays a monthly and daily parking fee and that each
employee receives a free unlimited Mobility Pass for transit. These scenarios benefit those employees who choose alternative modes and increases the cost of driving to make the alternative options more appealing.

From the MBTA’s perspective, each scenario proposed will result in an increase in revenue and will require the same amount of web portal modifications and billing improvements. From the Institute’s perspective, Scenario 3 will be the most costly, while Scenarios 1 and 2 will cost approximately $1 million annually to implement. In terms of the optimal scenario from the employee’s perspective, a $0 unlimited transit pass would be the ideal, but the scenario would cost $2-3 million annually. While Scenario 3 may seem costly, the worst case scenario ($2.9 million) represents only 62.9% of the total subsidy provided to annual parkers each year. Alternatively stated, a full cash-out scenario at MIT would cost $4.51 million, so Scenario 3 by comparison is only 62.9% of a full cash-out. This suggests that Scenario 3 is worth further consideration in the long-run.

**RECOMMENDED SCENARIO FOR MIT ALL-EMPLOYEE SOLUTION**

Scenario 2, with its costs outlined in Appendix B, is the recommended all-employee scenario for MIT. This scenario allows for annual parking permit holders to transition to the daily parking rate over time. It provides other employee groups the opportunity to pay-per-use for their parking while receiving an 80% subsidy on their monthly transit passes. The scenario expands the Mobility Pass to allow the entire employee community to take advantage of zero marginal cost transit.

Scenario 1, although easily implemented, does not allow annual parkers to switch to a daily parking rate, and therefore misses a key component of the incentives package. Scenario 3 would be ideal as offering free transit to an entire community while charging for parking and is the most effective scenario at reducing SOV mode share, but is expensive from an annual cost perspective. A logical next step would be for the Institute to pursue an all-employee solution, and move forward with Scenario 2 as a next step, and monitor the results, before considering Scenario 3 in the future.

In order to estimate the overall cost of the program, some assumptions were made about behavior change and included in the financial model. Based on the price elasticity of the current parking pricing changes each year, results from the Mobility Pass pilot program, as well as current parking and transit usage, the behavior change assumptions used in Scenario 2 are as follows:

- **Annual parking permit holders**
  - 40% convert to the daily parking rate option—Since the majority of annual parkers park less the 15 days per month (the breakeven point between annual and occasional parkers), we assume, given the saliency of a dashboard, that 40% of annual parkers will opt to pay for parking daily as it does not cost them more to pay daily (even with the monthly $15 transit and parking access charge), they get access to a low cost transit pass, and they could save money on the days they do not park.
  - We assume that those who switch to daily parking will park fewer days than those who remain annual parkers and adjust the amount those who voluntarily switch to daily parking accordingly (Parking Usage High is reduced from 14 to 10.5 and
Parking Usage Low is reduced from 12.6 to 9.5, based on the current distribution of parking use by the annual parking group).

- We assume that annual parking permit holders will continue to use transit between $3.00 and $6.50 per month based on the current usage of annual parkers who provided CharlieCard numbers to track and the previous Mobility Pass trial users.

- **Carpool/Vanpool**
  - We assume no change to the carpool/vanpool population, but we assume they will park between 13.5 and 15 days per month and they will use transit as often as the annual parking permit holders. This assumption is based upon usage data from the MIT parking office and the MBTA.

- **Occasional parking permit holders**
  - **With LinkPass**
    - We assume no change to the occasional parking population, but we assume they will park between 2.4 and 2.7 days per month and MIT will continue to pay $75 per month for their LinkPasses according to the policies established for the expanded Mobility Pass trial. This assumption is based upon usage data from the MIT parking office and the proposed MBTA policy.
  - **Without LinkPass**
    - We assume no change to the occasional parking population, but we assume they will park between 2.7 and 3.2 days per month and they will use transit between $8 and $12 per month (more than the annual parkers but less than those with LinkPasses). This assumption is based upon usage data from the MIT parking office and the MBTA.

- **LinkPass holders**
  - **With New Parking**
    - We assume that 20% of the LinkPass population will be willing to pay a $200 parking activation fee to allow them to park on campus for the daily rate. This group would save $22.50 per month on their transit expenses (paying $15 per month instead of $37.50) and could use that money to pay to participate in the parking program now that their transit is less expensive and they have space in their personal budget for additional parking expenses. This group is assumed to have the same parking usage as the Occasional Parker because they are essentially transitioning to become an Occasional parking permit holder with LinkPass.
    - MIT will continue to have to pay the MBTA for a full monthly LinkPass for these employees, so the transit payment remains $75 per month
  - **Without Parking**
    - We assume that the majority (80%) of current LinkPass holders will not opt-in to the parking fee and will benefit from paying $22.50 less per month in transit costs. They will still ride the T up to the maximum $75 per month worth of usage.
• Commuter Rail pass holders
  o With New Parking
    ▪ We assume that 20% of the Commuter Rail pass population will be willing to pay a $200 parking activation fee to allow them to occasionally park on campus for the daily rate. This group would save $22.50 per month on their transit expenses (paying an average of $73.59 per month instead of $37.50) and could use that money to pay to participate in the parking program now that their transit is less expensive and they have space in their personal budget for additional parking expenses.
    ▪ This group is assumed to have the same parking usage as the Occasional Parker because they are essentially transitioning to become an Occasional parking permit holder with commuter rail pass.
    ▪ MIT will continue to have to pay the MBTA for a full monthly average commuter rail pass for these employees, so the transit payment remains $192.18 per month on average based on the current zonal distribution of Commuter Rail passes.
  o Without Parking
    ▪ We assume that the majority (80%) of current Commuter Rail holders will not opt-in to the parking fee and will benefit from paying $22.50 less per month in transit costs. They will still purchase the commuter rail passes and MIT will continue to pay the MBTA $192.18 per month on average based on the zones passes purchased currently.
• Bike and Walkers
  o Opt-in with New Parking
    ▪ We assume 10% of the current bike and walk population will be interested in paying the $200 parking fee and participating in the $15 per month Mobility Pass. This will essentially transition them to the Occasional Parker with LinkPass group.
    ▪ We assume they will park as often as an Occasional Parker with LinkPass, but that their transit usage will be between the cost of a $15 per month Mobility Pass and $35. This is based on the fact that this group does not currently buy a $37.50 monthly LinkPass but are likely to buy one for $15 per month, suggesting that their usage is less than a current LinkPass but more than the cost of the proposed pass. This assumption is confirmed by the reports of CharlieCard usage by this group from the MIT Commuter Survey.
  o Opt-in without Parking
    ▪ We assume 40% of the current bike and walk population will be willing to opt-in to the $15 per month transit program based on the current CharlieCard usage and the fact that they did not opt-in to a $37.50 per month transit pass.
Opt-out

- We assume that 50% of the current bike and walk population will be unwilling to pay $15 per month for access to unlimited transit or the option of parking. This population will continue to participate in the $20 per month pre-tax bicycle benefit should they so choose.

As part of the full proposal of Scenario 2 to the MIT administration, located in Appendix D is an analysis of various pricing strategies that could be implemented under the assumptions of Scenario 2. In the analysis the price of the Mobility Pass, daily parking rate and annual parking cap were varied to determine their effect on the potential cost of the program to MIT. The scenario highlighted in orange (Scenario 14) represents the proposed solution while the scenarios in blue are other viable alternatives based on the preferences of the administration.

**Proposal to the Executive Vice President**

Located in Appendix D is a copy of the proposal sent to Israel Ruiz, Executive Vice President and Treasurer of MIT in March of 2015. The proposal outlines the costs associated with Scenario 2 and thoroughly describes the benefits of the proposed program, as well as the executive level costs associated with the implementation of the commuter dashboard and marketing strategy. The goal of the initial proposal was to provide each MIT employee with access to the new benefits as outlined in Scenario 2, and to measure the change in commuting behavior over the 2015-2016 calendar year. The fewer people who participate in the recommended benefits, the less MIT would pay for the program changes. For example, if parking behavior remained constant, MIT would receive more revenue from parkers and the proposed scenario would cost less than the estimates for Scenario 2. However, if there is a larger shift towards public transit, the Institute will pay more for providing the new benefit to its employees and would reap the benefit of reduced parking demand (and reduced leased parking spaces) for a fixed number of campus spaces.

**Recommended Experimental Design for a Sample MIT Population**

The MIT Executive Vice President suggested that instead of providing the new transportation benefit to the entire employee population, that an experiment should be designed to test the effectiveness of the incentives on a sample population of MIT employees first. After consultation with members of the MIT Parking and Transportation Committee, the following experiment was proposed by Research Associate John Attanucci and the research team:

Among both new employees and current employees (employees who have been at MIT over two years), there will be two groups: a control group and a treatment group. The treatment group will be exposed to the following set of incentives for behavior change:

- Daily parking at $8.50 per day, $15 per month parking + unlimited transit pass
- Access to commuter dashboard with weekly lottery
• 50% subsidy plus an additional $22.50/month off commuter rail passes
• If you were not previously a parker, pay $200 up front to receive the parking benefit, otherwise pay $15 per month for the transit benefit alone
• 50% reimbursement for MBTA parking garage fees

_for both new and current employees:_

Control group employees can choose from among the following commuter benefits:

• Annual parking permit. Employee pays $1600/year.
• Occasional parking permit. Employee pays $90/year and $8.50/day of parking.
• LinkPass or Commuter Rail permits. Employee pays $37.50/month for LinkPass.
• Bicycle reimbursement. Employee receives $20/month

_for new employees:_

Participants from the new employees will be randomly assigned to either the treatment group or the control group. Those included in the experiment must be assigned to a garage or lot that is gated, so that their parking usage can be tracked.

_for current employees:_

Employees for the treatment and control groups will be selected at random from the population of current employees who already park in a gated parking lot. Members of the control group that wish to add parking may do so without paying the additional $200 fee, but must be assigned to a gated parking lot. All treatment group employees who previously parked must participate in the daily parking program, with a cap on the total cost set to the cost of an annual parking permit ($1600/year). Occasional parkers in the treatment group who previously did not purchase a LinkPass will be reimbursed $7.50 per month in TechCASH for the $7.50 they are paying for a service that they may not use (MBTA) while participating in the experiment. (Currently, occasional parkers pay a fixed cost of $90 per year, which is $7.50 per month. Occasional parkers in the treatment group have a fixed cost of $15.00 per month, i.e. an additional $7.50 per month that covers an unlimited transit pass that an employee may not wish to use.)

**Sample size of treatment and control groups, each:**

_for new employees:_ Every employee hired from August-March will be added to either the treatment group or the control group. Half will be in each group, alternating between hires.

_for current employees:_ We need a sample of at least 625 employees for both the treatment group and the control group. This is based on the same sample size calculation done previously (see Appendix H for original calculation as performed by Gabriel Sanchez-Martinez) and discussed with Amy Finkelstein.
We expect the changes in behavior for parkers to be both more significant and more important to our study. Hence, we would like to meet the 625 minimum sample size for employees who park. We can accomplish this by having a strata of parkers and another of non-parkers, with sample sizes proportional to their size within the population. Employees who park represent about 45% of the employee population, so the experiment should have a total of 1500 participants: 680 parkers and 820 non-parkers. By maintaining the population proportions, we can treat this as a simple random sample when analyzing results.

Estimated Cost and Special Efforts for Experiment

The out-of-pocket benefit costs for the 2,000 or so (500 new plus 1500 current) employee participants in the experimental treatment groups, assuming a 12-month duration (Sep, 2015-August, 2016), would be up to $300,000 (prorated using our previous estimates for the full population under the selected pricing scenario). We estimate that the one-time cost of the dashboard and lottery tracking software platform procurement and development will be $50-$100,000, although this cost estimate should be refined. The experimental lottery prizes can be funded separately from a research grant that has allocated Federal funds for such an experiment. The biggest resource issue, however, is likely to be the marketing and administration of the program, including the community marketing/messaging that will have to be skillfully managed throughout the time that significant numbers of employees will be given different benefits and contacted several times for follow-up; the HR and Benefits folks should be consulted immediately regarding the basic feasibility of such an experiment. To do this correctly, we estimate that 1.5-2 additional FTE professional person-years will be required to set-up and manage the experiment in addition to additional resources being required from Human Resources, the ID card office, and current Parking and Transportation office personnel and services. In the end, we believe that the experiment will be about one-half of the cost of rolling out the “hybrid” recommended program proposed last month.

SUMMARY OF RECOMMENDATIONS FOR MIT- INCENTIVES AND IMPLEMENTATION

As a large employer with access to employee MBTA data, parking access information, and a high transit mode share, MIT should consider implementing incentives that will best promote alternative modes and provide an equitable program to its many employee groups. MIT should implement a commuter dashboard that provides employees with information on their commutes and the opportunity to compete against their co-workers and neighbors in collecting credits towards cash prizes. MIT should also expand the Mobility Pass to each employee for $15 per month, allowing access to zero marginal cost transit and the ability to pay $8.50 per day to park. This change would make the decision to park each day cost $8.50, while making other mode choices such as bicycling, walking or transit more appealing and worth consideration. The change from annual to daily parking should occur gradually over the course of a year as not all parking lots on campus are behind a pay gate currently. The switch to daily rates will allow frequent parkers to consider taking another mode occasionally to commute without the concern that any transit trip would cost more on top of the annual parking fee.
All incentives should be heavily marketed by MIT and financial incentives provided through the lottery and paid through the payroll system to promote non-SOV commuting.

**Drawbacks to Using a Sample Population Experiment**

MIT should consider implementing an all-employee incentive program instead of a sample population experiment. From an implementation perspective, although an experiment on a sample MIT population would be beneficial in terms of controlling experimental variables and directly measuring the impact of certain incentives on behavior directly, it is challenging to put an experiment in place concerning differences in employee benefits. In the randomized experimental design proposed, MIT would be providing some employees with $15 transit passes while others paid $37.50 per month for them. Employees in the treatment group would receive access to participate in lotteries for cash prizes not available to all employees. Even if it was agreed upon from the beginning of the experiment that those who did not initially receive a benefit would be paid the benefit at the end of the experiment, researchers could not tell the participants of reimbursement plans because it would potentially affect the behavioral response of the participant. The author recommends that MIT consider implementing Scenario 2 for all employees and measure the impact on the entire employee population in order to maintain equity among employees who will undoubtedly determine that they are being treated differently by their employer if a randomized study is implemented.

**5.3.2. Other Kendall Square Employers to Target**

In order to assess how well each incentive works in an urban environment with access to a variety of commuting options, the experiment must include a variety of employers that may respond differently to different incentives. This section provides a list of employers that should be approached to be considered for the experiment as well as the types of incentives that may change mode share the most for each organization based on the factors described in Section 5.1. The list of employers and much of the background information was assembled by Matthew Hartnett, a research assistant in the MIT Transit Lab. The employers were included on this list based on their size, location and current transportation benefits packages, as well as their perceived willingness to participate in the experiment.

**Novartis**

Novartis is a pharmaceutical corporation who has been in Cambridge since 2002 and is consistently growing in size near Kendall. Novartis has more than 1,800 employees distributed across two campuses in the Kendall Square area. Novartis charges employees about market rate for parking and offers partial cash-out transportation benefits. However, employees must choose either transit or parking benefits. Employees are offered their choice of $100/mo to apply towards parking or $125/mo towards transit expenses. Novartis also offers significant parking cost discounts to carpoolers. The most recently reported estimated SOV rate is approximately 31% (2012). Novartis is a member of the CRTMA.

Address:

Technology Square Campus: 100, 200, 300 and 500 Technology Square
Massachusetts Avenue Campus: 186, 209-211, 220, 250 and 301 Massachusetts Avenue and 45 Sidney Street

**RECOMMENDED INCENTIVES**

As a reasonably large organization in an urban area with good proximity to alternatives and a high transit mode share, Novartis should consider incentives based on the Criteria-Incentive Decision Matrix found in Table 5-1. The matrix suggests Novartis consider the following incentives:

- Universal transit pass
- Combined “Transportation Benefit” cash-out- include both transit and parking benefits
- Daily parking rates
- Commuter dashboard (with lottery and heavy marketing campaign)

Novartis has an unknown marketing capacity, which may affect which incentives will remain under consideration after meeting with potential administrators in the organization.

**THE CHARLES DRAPER LAB**

The Charles Draper Lab is a non-profit research and development organization which was founded as a part of MIT in 1932 and became an independent entity in 1973. As of 2012, the organization had approximately 1,200 employees in Cambridge and continues to be a member of the CRTMA. The headquarters is located less than one half mile from the Kendall/MIT T station. The Draper Lab heavily subsidizes parking for employees, who pay $35 per month to park, and offers a significant transit subsidy ($115 per month). Employees must choose between the subsidized parking or the transit benefit, however, those using the transit benefit may also have access to parking for $70 per month. The most recently reported estimated SOV rate is approximately 51%, which is significantly higher than the Kendall Square average of 22.7%. By subsidizing driving so heavily, Draper is promoting SOV commuting.

Address: 555 Technology Square

**RECOMMENDED INCENTIVES**

As a medium-sized organization in an urban area with good proximity to alternatives and a low transit mode share (high SOV rate), Draper should consider incentives based on the Criteria-Incentive Decision Matrix found in Table 5-1. The matrix suggests Draper consider the following incentives:

- Universal transit pass
- Daily parking rates
- Commuter dashboard (with lottery and heavy marketing campaign)
- Combined “Transportation Benefit” cash-out- include both transit and parking benefits
**Pfizer**

During the summer of 2014, Pfizer consolidated a workforce of about 1,000 (originally divided among three area workplaces) to a 280,000 square foot research and development complex in Kendall Square. There is no data available describing TDM measures the company has in place at this new location, but the company may serve as an interesting candidate for this experiment as its workforce is new to the Kendall Square area. Recent 2014 data from a Pfizer location at nearby 300 Tech Square indicates that Pfizer did not charge employees for parking at that location. Data from 2012 from one of the company’s former locations in Alewife reports that location employees could receive 100% of the federal pre-tax benefit level for transit expenses, or $135 per month. Pfizer is a Charles River TMA member but does not contribute to, or participate in the EZRide Shuttle service. Pfizer is located less than one half mile from the Kendall/MIT T Station.

**Address:** 610 and 700 Main Street

**Recommended Incentives**

As a medium-sized organization in an urban area with good proximity to alternatives and a low transit mode share, Pfizer should consider incentives based on the Criteria-Incentive Decision Matrix found in Table 5-1 as well as the fact that they can use their new location as a “teachable moment” for their employees to consider a new commuting mode choice. The matrix suggests Pfizer consider the following incentives:

- Universal transit pass
- Daily parking rates
- Commuter dashboard (with lottery and heavy marketing campaign)
- Combined “Transportation Benefit” cash-out- include both transit and parking benefits
- Establish Bike to Work Week initiative

**Millennium**

Founded in Cambridge in 1993, Millennium is a mid-size biopharmaceutical company with over 1,250 employees in the Kendall Square area. Employees receive subsidized parking at local garages that are affiliated with the owner of the property but also open to the public for a high daily rate ($30). Millennium employees pay for a portion of the true cost of parking on a rolling scale based on their income. Required employee contributions range from $26-97.50 per month. Millennium offers a transit subsidy of $110 per month or an “opt out” benefit of $175 in taxable income per quarter ($58.33 per month). Upon hiring, employees must choose which benefit they would like to receive: parking, transit or opt out. Employees may change their transportation benefit preference from quarter to quarter, and only during a quarter under extenuating circumstances. The most recently reported estimated SOV rate is approximately 68% (as of 2012). Millennium has access to CRTMA benefits and services through the membership of the property site owner.

**Address:** 35 and 40 Landsdowne Street, 350 Massachusetts Avenue and 64 and 75 Sidney Street
**Recommended Incentives**

As a medium-sized organization in an urban area with good proximity to alternatives and a low transit mode share, Millenium should consider incentives based on the Criteria-Incentive Decision Matrix found in Table 5-1. The matrix suggests Millenium consider the following incentives:

- Universal transit pass
- Daily parking rates (instead of monthly) and charge a higher daily rate for everyone, providing a partial cash-out subsidy based on income
- Commuter dashboard (with lottery and heavy marketing campaign)
- Combined “Transportation Benefit” cash-out- include both transit and parking benefits

**InterSystems**

Headquartered in Cambridge since 1996, InterSystems is a software development company with over 1,000 employees. Employees pay market rate for parking in Kendall Square, as their space is 0.3 miles from the Kendall/MIT T station. InterSystems offers no transit subsidy to employees but allows for the pre-tax purchase of transit passes through payroll deduction. Just under 40% of employees were reported to participate in the corporate pass program. Because InterSystems employees currently pay market rate for parking, this company is not a good candidate for cash-out as the employer will spend a significant sum of money paying for benefits it was not previously providing. If InterSystems does not wish to expend significant funds during the experiment, it should focus on less expensive incentives.

Address: 1 Memorial Drive

**Recommended Incentives**

As a mid-size organization in an urban area with good proximity to alternatives and a high transit mode share, InterSystems should consider incentives based on the Criteria-Incentive Decision Matrix found in Table 5-1. The matrix suggests InterSystems consider the following incentives:

- Universal transit pass
- Establish Bike to Work Week initiative
- Temporary commuter dashboard (with lottery and marketing campaign paid for by funds from experimental budget)
- Offer discounted parking to carpool and vanpools

**Royal Sonesta Hotel**

Located in between Lechmere and Kendall—within half a mile from Lechmere and within one mile of Kendall, the hotel is positioned to offer its more than 300 employees transportation benefits such as subsidized parking and transit passes. The hotel subsidizes half the cost of parking for employers
and offers a 45% subsidy for the purchase of transit passes. The remaining cost can be paid for through pre-tax payroll deduction. About a third of employees currently participate in the MBTA corporate pass program. The hotel commuting is likely characterized by employee schedules and wages that may be quite different than those observed at many of the other employers under consideration for this experiment.

Address: 40 Edwin Land Boulevard

RECOMMENDED INCENTIVES
As a small organization in an urban area with good proximity to alternatives and a low transit mode share, Royal Sonesta should consider incentives based on the Criteria-Incentive Decision Matrix found in Table 5-1. The matrix suggests Royal Sonesta consider the following incentives:

- Universal transit pass
- Daily parking rates
- Temporary commuter dashboard (with lottery and marketing campaign paid for by funds from experimental budget)

5.4 SUMMARY OF PROPOSED INCENTIVES AND METHODOLOGY FOR IMPLEMENTATION
The first section of this chapter discussed the criteria for choosing incentives based on the characteristics of organizations: current commuting behavior, the size of the institution, size of marketing capacity, proximity of alternatives and the geographic location of an employer. Each factor makes certain incentives more likely to be successful, such as a large employer benefiting more from a commuter dashboard than a small employer. The proposed incentives to be considered for Kendall Square employers include the steps required for an expanded universal pass, the introduction of daily parking rates, parking cash-out, and a dashboard. The chapter then describes the steps needed to design and perform the experiment at MIT, as well as provides a list of other potential employers and recommended incentives to be considered for each. MIT should implement an expanded Mobility Pass, daily parking rate, a commuter dashboard with lottery component, and a heavy marketing campaign for its entire employee population. Other employers in the area should be pursued and provided with the list of recommended incentives to consider in order to perform the experiment beginning in September 2015.
6. **DESIGN DOCUMENT FOR THE COMMUTER DASHBOARD TOOL**

Chapter 6 contains recommendations for enhanced social media interaction, as well as the conceptual design and user interface of the commuter dashboard. The dashboard displays information on individual’s work commutes by integrating employee parking information with MBTA CharlieCard usage, and biking and walking data from the *Moves* mobile application (*Moves*, 2015) to create a snapshot of employee’s commuting behavior. The commuter dashboard is used to show individuals their commuting patterns and be the platform for changes to those patterns through the application of behavioral and financial incentives. The proposed dashboard also contains gamification elements to promote competition between individuals and groups, as well as prizes for individual achievement that emphasize long-term behavior change.

6.1 **RECOMMENDATIONS FOR EFFECTIVE SOCIAL MEDIA APPLICATIONS**

According to user experience experts, social media applications follow the 90-9-1 rule for participation: 90% of users never contribute (i.e., read or observe), 9% contribute a little, and 1% account for practically all of the activity on a website (Nielsen, 2006). With this in mind, the commuter dashboard should follow a set of principles aimed at providing the contributors and non-contributors alike with the most benefit from the application as possible. The principles are outlined as follows:

1. **Make it easy to contribute to the commuter dashboard**
   Make the log-in process simple and straightforward, and make the process for signing up for the commuter dashboard as seamless as possible. Additionally, trips should appear automatically so the user doesn’t have to log their own trips and fill them into the application manually.

2. **Make participation a side effect of the design**
   Track user behavior and automatically upload their trips to the site. Allowing users to participate in lotteries without having to log their trips in the system means they’re more likely to participate because their contributions (trips) are a side effect of something they were already doing (commuting to work).

3. **Edit, don’t create**
   Users shouldn’t have to decide which modes they want to be a part of their dashboard. They should, however, have the opportunity to show or hide modules from their view. For example, if they know they are never going to drive because they do not own a car, they should be able to edit the dashboard to remove that mode from their view.
4. Reward, but don’t over-reward participants
   Give contributors preferential treatment over non-contributors in the application, such as
giving them special financial incentives or put a gold star on their profile to show that they are
one of the more active users of the application. This will motivate non-contributors to log in
to the application more often.

In order to ensure the commuter dashboard follows all of these criteria, the design must allow
simplified log-ins, track individual’s behavior with very little input, allow users to select from pre-
designed widgets, and give rewards to active users of the application. The design will be discussed in
the next section.

6.2 COMMUTER DASHBOARD DESIGN
The Dashboard must retrieve data from various sources, process that information, and disseminate
summarized information about individual users. When assembling a dashboard of any kind, it is
important to consider both the items that should be included for the end-user to view (and the user
interface) as well as the back-end information that must be captured and re-processed before it is
displayed to the individual users. The first consideration is the user interface of the dashboard, which
helps determine what data is required to accomplish the front-end display.

6.2.1. USER INTERFACE CONCEPTUAL DESIGN
The user interface must contain a high level summary of the individual’s travel behavior and be
interactive as well as aesthetically pleasing. The dashboard houses information from many different
sources (see Section 6.2.2) and provides a method to communicate with participants. The interface
can be used both to introduce new incentives (such as points promotions on certain commuting
modes throughout the week) as well as offer employees the opportunity to play a game towards a
larger lottery prize.

The front-end of the conceptual design consists of three main pages: the home screen, the mode split
screen, and the lottery game screen. The home screen contains a summary of all modes taken over the
course of the past twelve weeks of commutes. It shows the total alternative modes taken and the
points earned towards cash prizes as well as how an individual compares to his/her peers at the
Department level, the employee level, and against people who live near them. As seen in

Figure 6-1 below, the home screen allows users to compare themselves to various points leaderboards,
as well as review their mode choice over the 12 week period. Participants are given a gold star at the
top of the home screen if they log in to the site more than once per week in order to reward users for
active use. Participants are also issued a badge based on the number of points they earned over the
previous week, where the badges are associated a user’s rank and determine how much can be earned
in the lottery game.
Your Commute This Month

- Alternative Trips Taken Past 30 Days: 8
- Points Earned: 230
- Cost of Commute, Year to Date: $1,037

How do you compare?

- Department Rank: 76 out of 100 people
  You did worse than 76% of your department
- MIT Employee Rank: 99
  You did worse than 53% of MIT employees
- Your neighbors Rank: 18 out of 24
  You did better than 75% of your neighbors

Leaderboard

<table>
<thead>
<tr>
<th>Name</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul Revere</td>
<td>1020</td>
</tr>
<tr>
<td>John Smith</td>
<td>1010</td>
</tr>
<tr>
<td>Samuel Adams</td>
<td>980</td>
</tr>
<tr>
<td>Patrick Henry</td>
<td>980</td>
</tr>
<tr>
<td>Ben Franklin</td>
<td>970</td>
</tr>
</tbody>
</table>
Points are collected according to a combination of the distance a commuter lives from MIT and the ease with which they can consider an alternative. The easier the switch is (for example, switching from driving to transit when a user lives next to a T station), and the closer an employee lives from campus (within five miles), the higher the points awarded to a commuter dashboard user for the trip. Each trip made on alternative modes results in more points for the user. According to Fangping Lu’s analysis, four time-based “zones” can be formed based on self-reported MIT employee commute times for walking, bicycling, or transit in order to assign points based on the length of their commutes: 0-30 minutes, 31-45 minutes, 46-60 minutes and above 60 minutes. Points are then distributed differently based on the user’s primary mode within those zones, with the highest points assigned to those whose primary mode is driving alone, and who instead walk or bicycle to work and live within a 45 minute walk, bike, or transit ride of MIT. The lowest points are distributed to those who carpool or are dropped off at work who live within a 30 minute walk, bike, or transit trip of MIT. Zero points are given to those employees who continue to drive alone.

Badges are awarded based on the previous week’s points collection according to the following scale:

<table>
<thead>
<tr>
<th>Badge Name</th>
<th>Minimum Points Acquired in Previous Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traveler</td>
<td>30</td>
</tr>
<tr>
<td>Navigator</td>
<td>60</td>
</tr>
<tr>
<td>Master Explorer</td>
<td>90</td>
</tr>
<tr>
<td>Commute Commander</td>
<td>120</td>
</tr>
</tbody>
</table>

Active users (those with gold stars on their screen) will receive an additional 5 points per week for logging into the dashboard more than once per week. Users can earn additional points through weekly promotions that temporarily increase the value of specific modes (such as carpooling) to keep users engaged in the experiment and in the application.

The mode split screen (Figure 6-2) displays commuting activity by mode for the previous four months, as well as a current breakdown of the modes used over the last month and a cost estimate of expenses associated to each mode. The users are compared to their peers to indicate whether they are below, at, or above average for use of each mode. The modes included on this screen are driving alone, carpooling, train or bus use, walking or biking.

The mode split screen shows driving behavior including both Drive Alone and Carpooling entries. Driving costs are calculated based on the annual cost of the employee parking permit, daily parking charges at the employer site, number of days parked, cost of wear and tear on the vehicle from an employee’s home to work addresses, and average cost of gasoline. The wear and tear and gasoline charges are calculated by multiplying the standard federal cost of driving for business purposes in 2015 (57.5 cents per mile by the mileage between employee home and work locations (as defined by Google Maps® recommendations). The driving costs are calculated by week and current month.
Bicycle and Walking data is displayed based on trips and calorie calculations from the *Moves* mobile application. Optionally, a map of all trips made by walking or bicycle in the previous week or month can be included in this widget through inclusion of more data from the *Moves* app.

The public transit information is collected based on the MBTA fare transactions. The most recent four months of data are included in the display and variable transit costs are calculated based on whether the employer is charging employees based on a fixed monthly cost or a variable, pay-per-ride value. For MIT, it is proposed that employees will pay $15 per month for a transit pass and the average cost per trip is based on the total number of trips a user takes per month. Each trip reduces the average cost per trip. This value is calculated by dividing the total fixed cost of a monthly pass for each employee by the number trips made on public transportation for the current month. Currently, use of the Commuter Rail is included only if that user has purchased a Commuter Rail pass and then proceeds to tap into the T after taking the commuter rail to a train or bus to their office. The Commuter Rail pass does not require a tap on the commuter train and therefore rides on the commuter rail cannot be tracked through the MBTA Automated Fare Collection data. Monthly passes purchased as Commuter Rail Zonal passes can be tracked separately from LinkPasses for rides on T, but there is no indication which stations were used while the passholder was on the commuter rail portion of the transit system.
Driving and Carpooling

Historical Data

This Month
Days Parked: 5
Days Carpoled: 1

Driving Costs
This Week: $57
This Month: $63

Compared to
Department Avg: Above Avg
MIT Employee Avg: Avg
Your neighbors: Below Avg

Biking and Walking

Historical Data

This Month
Days Biked: 5
Days Walked: 3

Walking and Biking Calories Burned
This Week: 3,471
This Month: 7,320

Compared to
Department Avg: Above Avg
MIT Employee Avg: Avg
Your neighbors: Below Avg

Transit

Historical Data

This Month
Bus: 6 days
Train: 1 day

Transit Costs
This Month: $20
Average Cost per trip: $2.86

Compared to
Department Avg: Above Avg
MIT Employee Avg: Avg
Your neighbors: Below Avg
The lottery screen (Figure 6-3) allows users to exchange their points for cash and is accessible through the “Click Here to Turn Points into Cash” button on the home screen. The lottery and game component increase user’s potential interaction with the application, motivating participants to log in to the system more frequently and increase their alternative modes in order to play the game and win more prizes. The screen includes an option to convert 100 points into $2 which can be submitted to the employer’s payroll system, or choose to play a game using the points in order to have the chance to win a larger cash prize. The game is played by spinning the commuter wheel and clicking on the resulting commuter types that appear. Collecting three different commuters results in winning the lottery, which will increase in likelihood based on the number of points collected by the user.

FIGURE 6-3: COMMUTER DASHBOARD LOTTERY SCREEN

The likelihood of collecting three commuters and winning the $20 lottery is as follows:

TABLE 6-2: LIKELIHOOD OF WINNING LOTTERY BASED ON POINTS COLLECTED

<table>
<thead>
<tr>
<th>Point Range</th>
<th>Likelihood of Winning $20 Lottery</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30</td>
<td>2%</td>
</tr>
<tr>
<td>31-50</td>
<td>5%</td>
</tr>
<tr>
<td>51-150</td>
<td>7.5%</td>
</tr>
<tr>
<td>151-250</td>
<td>10%</td>
</tr>
<tr>
<td>251-350</td>
<td>20%</td>
</tr>
<tr>
<td>351-450</td>
<td>25%</td>
</tr>
<tr>
<td>451+</td>
<td>30%</td>
</tr>
</tbody>
</table>

As the participants increase their overall rank in the Dashboard from Traveler up to Commuting Commander, their baseline lottery value will increase from $20 to $100. As a Navigator, their lottery
prize will be $40, and as a Master Explorer their prize will be $60. Increasing the size of the prize based on a user’s previous week’s points motivates participants to choose alternative modes more frequently in the long-term as they can win larger prizes if they are more highly ranked. Increasing the likelihood of winning the lottery based on a user’s current points allows users to use their points in the short-term, or save them for a future week to improve their odds at winning a larger amount with a larger number of points.

If there are 10,000 people who participate in the commuter dashboard and they are each awarded approximately 50 points per week, they can exchange the 100 points for $2 every two weeks, or they can play the lottery every two weeks for a 7.5% chance of winning $20. According to the Stanford study, approximately 80% of participants opted to play the game of chance. If approximately one half of the 10,000 people log in each week and play the game, financial incentives could equal about $3,000 per week for the program using the points/prize size parameters discussed above. The parameters of the lottery prizes can be modified over time to reflect program budget constraints and to promote certain modes (increase the value of carpooling during a special “promotional” period).

6.2.2. DATA SOURCES
This section contains the list of data sources required by the Dashboard as well as the data and method required to integrate them into the application. The data sources are presented in order of their importance in the success of the application such that if certain data sources are unavailable or more challenging to acquire, the focus should be on the employee MBTA and parking data first. The data sources described in this section include: MBTA CharlieCard transactions, parking lot transactions, the Moves application trips, carpool tracking, and flat file uploads of both permit pricing and demographic information.

MBTA DATA- CHARLIECARD TAPS
The Automated Fare Collection (AFC) system measures each time a farebox is used with cash or card whether for an initial trip or transfer. Each fare transaction from AFC specifies the type of account used to pay for the ride (cash, CharlieCard monthly pass, CharlieCard stored value), the time and date the transaction took place, and the location of the transaction. This data allows the dashboard to track individual CharlieCards associated to an employee and note the number of times used and the type of payment used. Assuming that all program participants are given an unlimited use monthly pass as is currently anticipated, the dashboard should count only monthly pass, non-transfer, CharlieCard transactions while removing stored value transactions because the MBTA system allows multiple taps of the card at the same station to use the card for multiple riders. The first tap is associated to the monthly pass, while the second tap of the card pulls funds from the cash value stored on the card. Counting both stored value and monthly pass transactions could result in double-counting trips on which the card was tapped multiple times at the same station in rapid succession. Additionally, transfer taps will be included in the data that is sent to the dashboard for calculating the total cost of the commuting trips.

The MBTA uses certain codes to denote which farebox was used in the transaction and other small transit systems in the state use the CharlieCard for their fare systems so the correct codes need to be
specified that correspond to the MBTA rail and bus fareboxes. In the fare transaction data, the 'deviceclassid' that refers to MBTA buses are 501 and 503. The MBTA train codes are 201, 202, 205, 206, 411, 412, 441, and 442. These are the only codes that should be pulled from the fare transactions table that should be used in the dashboard.

Additionally, the timestamp on MBTA fare transactions allows the dashboard to determine which month the transactions should be associated. Finally, the CharlieCard number is the link between the dashboard user and their public transportation transactions, and is the primary key for connecting all other commuting and demographic information to the user. This information should be included in the data sent to the dashboard from the MBTA server.

Below is a summary of fare transaction data from the most recent afc.faretransaction table to be sent from the MBTA to the dashboard on a weekly basis:

**TABLE 6-3: MBTA FARE TRANSACTION DATA FIELDS**

<table>
<thead>
<tr>
<th>Name of field in MBTA server</th>
<th>Data type</th>
<th>Sample data</th>
<th>Notes on data field</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Train or Bus?</strong></td>
<td>Deviceclassid</td>
<td>smallint</td>
<td>411</td>
</tr>
<tr>
<td><strong>Time and Date of Transaction</strong></td>
<td>Trxtime</td>
<td>Timestamp without time zone</td>
<td>2014-03-01 07:15:04</td>
</tr>
<tr>
<td><strong>Type of Fare Payment</strong></td>
<td>tickettypeid</td>
<td>bigint</td>
<td>602800100</td>
</tr>
<tr>
<td><strong>CharlieCard Number</strong></td>
<td>ticketserial</td>
<td>bigint</td>
<td>3425613259</td>
</tr>
</tbody>
</table>

The cost of each transaction can be calculated through the application developed by the MIT Transit Lab to determine the Mobility Pass pilot project bill for the MBTA to charge MIT. For the dashboard, only the first two full-fare trips (non-transfer) on weekdays can be associated to a person’s commute trips and count towards the lottery. All other transactions should not be included towards the lottery, but should be used for billing employees for their use should employers choose to charge their employees per trip at a discounted rate, which they can bill monthly.

**PARKING DATA- TAPS IN AND OUT OF GARAGES**

For the parking data to be included in the commuter dashboard, each employer must have access to its employee’s individual parking data and have a way to tie employees to their parking behavior.
(through an electronic ID). In the case of MIT, the parking gates read a parking card number which is associated to the MIT ID in the parking data warehouse. Before the parking data is sent from the data warehouse to the commuter dashboard, the parking card number must be matched to the employee MIT ID. MIT employees may have multiple parking card numbers (which is associated to individual permits on vehicles) if they have registered multiple vehicles with the MIT parking office. The MIT parking system currently registers entries and exits from 65% of parking garages on campus. The other 35% are ungated lots. Employees of MIT who participate in the incentives experiment must park in a gated lot each day in order to register for the commuter dashboard. Other sensors may be installed for the other ungated lots which will allow their use as part of the dashboard and allow 100% tracking of parking behavior at the Institute.

The data required by the commuter dashboard from the parking data warehouse are the MIT ID and the date and time of the first parking entry of each new day. Some processing of the data must occur in the data warehouse before being sent to the Dashboard. Parking on campus should only be tracked on weekdays (weekends are not to be included in the dashboard measures) and the parking gate must register a ‘Valid Access’ entry. Only the first entry of each weekday for each unique MIT ID should be included and sent to the dashboard, as employees are charged for parking each day, not upon entry to multiple garages in the same day, or the same garage multiple times in one day.

Below is a summary of the MIT parking transaction data from the most recent parking data warehouse table to be sent from the MIT data warehouse on a weekly basis:

**TABLE 6-4: MIT PARKING TRANSACTION DATA FIELDS**

<table>
<thead>
<tr>
<th>Name of field in parking server</th>
<th>Data type</th>
<th>Sample data</th>
<th>Notes on data field</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT ID</td>
<td>Mitid</td>
<td>bigint</td>
<td>913688131</td>
</tr>
<tr>
<td>Date and Time</td>
<td>date</td>
<td>Timestamp</td>
<td>10/01/2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>without</td>
<td>00:00:35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>time zone</td>
<td></td>
</tr>
</tbody>
</table>

**CURRENT PRICING BREAKDOWN OF ACTIVITIES**

The costs of each activity included in the commuter dashboard should be based on data from a flat file uploaded to the dashboard each time the pricing scheme changes. This flat file should include the cost of each parking permit type, transit pass type, and daily parking charges. The parking permit types include Annual Parking permit fee, Occasional parking fee, etc., while the transit permit types include zonal passes on the Commuter Rail, ferries, LinkPass, Mobility Pass pricing and more. The file should be reviewed each quarter and re-uploaded to the Dashboard as needed.

Located in Appendix E is a complete list of the data fields required in the Pricing flat file that should be sent as a .csv file to the Dashboard as needed.
**DEMOGRAPHIC INFORMATION**

Participants must provide access to some of their demographic and permit type information in order to participate in the commuter dashboard. This information is used to compare commutes between similar employees and to track the overall progress each user group is making towards reducing mode share. A flat .csv file should be sent monthly with updated demographic information collected from the parking data warehouse, the MIT Parking and Transportation Office, and MIT Human Resources to keep the application properly updated. Each line in this file will be an individual MIT commuter dashboard user with all pertinent data associated to that user. For example, if a user has a transit permit but no parking permit, the parking permit field will be left blank while the transit permit will be included in line with their home ZIP code or Census Block Group ID and Department.

**TABLE 6-5: DEMOGRAPHIC INFORMATION FLAT FILE FIELDS**

<table>
<thead>
<tr>
<th>Name of field in data warehouse</th>
<th>Data type</th>
<th>Sample data</th>
<th>Notes on data field</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT ID</td>
<td>Mitid</td>
<td>bigint</td>
<td>913688131</td>
</tr>
<tr>
<td>Parking Permit Type</td>
<td>ppermittype</td>
<td>CHAR(3)</td>
<td>OCP</td>
</tr>
<tr>
<td>Transit Permit Type</td>
<td>tpermittype</td>
<td>CHAR(3)</td>
<td>MOB</td>
</tr>
<tr>
<td>Home ZIP Code</td>
<td>homezip</td>
<td>bigint</td>
<td>02139</td>
</tr>
<tr>
<td>Home Block Group ID</td>
<td>homeblkgrp</td>
<td>bigint</td>
<td>330150610011</td>
</tr>
<tr>
<td>Department</td>
<td>empdept</td>
<td>CHAR(2)</td>
<td>CE</td>
</tr>
<tr>
<td>Employee Type</td>
<td>emptype</td>
<td>CHAR(3)</td>
<td>FAC</td>
</tr>
<tr>
<td>CharlieCard Number</td>
<td>ticketserial</td>
<td>bigint</td>
<td>3425613259</td>
</tr>
</tbody>
</table>

**MOVES API FOR WALKING AND BIKING**

In order to record walking or bicycling trips, employees who wish to participate in the commuter dashboard must download a mobile application called *Moves* onto their cell phones. This application uses the sensors on user's mobile device to track how long a user travels and which modes were used. The application can sense the difference between walking, bicycling, riding on a bus, and driving a car and provides users with a daily summary of the modes taken and length of time spent in each mode. The app also displays calories burned and distance traveled for each mode. Users of Moves will be
required to share their Moves ID with the commuter dashboard application upon signing up for the dashboard so that the tracked information can be included.

The commuter dashboard should include both the number of commutes taken by bicycle and walking without registering car travel for the same individual through the Moves app. The commuter dashboard should receive a processed file that contains trips that either originate at the employee's home location and end at work or vice versa, that are performed by walking, running or biking. A maximum of two trips should be collected each day representing the commute to or from work. If the user has a work location associated to a weekday in the Moves data, and that day contains no driving or public transportation trips, then the user receives credit for either bicycling or walking that day. If the day contains two bicycling trips (one originating and one ending at a home location), then the user will receive credit for two bicycle commute trips for the day.

Below is a summary of the information that should be sent from the Moves application:

**TABLE 6-6: MOVES APPLICATION TRANSACTION DATA FIELDS**

<table>
<thead>
<tr>
<th>Name of field in Transit Lab Moves server</th>
<th>Data type</th>
<th>Sample data</th>
<th>Notes on data field</th>
</tr>
</thead>
<tbody>
<tr>
<td>User ID</td>
<td>Places.User_id</td>
<td>bigint</td>
<td>123456789</td>
</tr>
<tr>
<td>Date</td>
<td>Activity.Date</td>
<td>Timestamp-yyyyMMdd</td>
<td>20150510</td>
</tr>
<tr>
<td>Segment ID</td>
<td>Activity.Segment_id</td>
<td>smallint</td>
<td>12</td>
</tr>
<tr>
<td>Place Type</td>
<td>Places.type</td>
<td>string</td>
<td>“home”</td>
</tr>
<tr>
<td>Activity Type</td>
<td>Activity.Activity._type</td>
<td>string</td>
<td>“walking”</td>
</tr>
<tr>
<td>Activity Start Time</td>
<td>Activity.Activity._start_time</td>
<td>ISO 8601 (yyyyMMdd'T'HHmmssZ)</td>
<td>20121212T160720+0200</td>
</tr>
<tr>
<td>Activity End Time</td>
<td>Activity.Activity._end_time</td>
<td>ISO 8601 (yyyyMMdd'T'HHmmssZ)</td>
<td>20121212T160744+0200</td>
</tr>
</tbody>
</table>
### CARPOOL TRACKING

In order to track carpooling activities through the commuter dashboard, employers must have a method of registering carpoolers that validates carpooling trips, besides through self-reporting. MIT should consider installing a carpool MIT ID reader on the passenger side of the entrance to select parking garages. The reader can validate that when a primary carpool permit holder taps the parking gate reader, they do not receive carpooling credit unless a different card is used to tap into the passenger-side reader within ten seconds in order to validate that a carpooling transaction has taken place. The transaction can then be passed to the commuter dashboard system using the same data format as the parking data previously discussed but with a new field to mark both the carpooling driver and passenger separately from the Drive Alone parkers.

Below is a summary of the additional information that should be sent from the parking data warehouse to the Dashboard:

<table>
<thead>
<tr>
<th>Field</th>
<th>Data Type</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start latitude of the activity</td>
<td>Latitude coordinate</td>
<td>55.5555</td>
<td>Start and ending latitude and longitude can be mapped and a distance for travel determined</td>
</tr>
<tr>
<td>Start longitude of the activity</td>
<td>Longitude coordinate</td>
<td>33.3333</td>
<td>Start and ending latitude and longitude can be mapped</td>
</tr>
<tr>
<td>End latitude of activity</td>
<td>Latitude coordinate</td>
<td>55.5555</td>
<td></td>
</tr>
<tr>
<td>End longitude of activity</td>
<td>Longitude coordinate</td>
<td>33.3333</td>
<td></td>
</tr>
<tr>
<td>Distance</td>
<td>smallint</td>
<td>1086</td>
<td>Distance traveled in meters (should be processed and converted to miles)</td>
</tr>
<tr>
<td>Calories burned</td>
<td>smallint</td>
<td>99</td>
<td>-Activity.Calories is the new field that needs to be added</td>
</tr>
</tbody>
</table>

(CActivity_end_time - Activity_start_time) and convert to minutes

"***New data not yet tracked in the Transit Lab server but available from Moves"
<table>
<thead>
<tr>
<th>Name of field in data warehouse</th>
<th>Data type</th>
<th>Sample data</th>
<th>Notes on data field</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT ID</td>
<td>Mitid bigint</td>
<td>913688131</td>
<td></td>
</tr>
<tr>
<td>Date and Time</td>
<td>date Timestamp</td>
<td>10/01/2013</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>00:00:35</td>
<td></td>
</tr>
<tr>
<td>Carpool Trip</td>
<td>Carpool** int</td>
<td>1</td>
<td>Binary- if carpool, then send 1, else, 0 to commuter dashboard</td>
</tr>
</tbody>
</table>

**TABLE 6-7: CARPOOL TRANSACTION DATA FIELDS**

6.3 **SUMMARY AND CONTINUED WORK**

The commuter dashboard is a tool through which users can track their commuting behavior without the reliance on self-reporting. By integrating data from various modes in one place, users can participate in promotions designed to encourage alternatives to single-occupant vehicle work commutes and see the results of their commuting choices on the application in real time. It is important to update the data in the application frequently and provide employees with a user-friendly interface that does not require heavy input from individuals both in the set-up process and the tracking behavior. The research team has identified a potential partner in a third-party software application called RideAmigos.

Capable of easily forming carpools amongst its users and displaying badges for alternative mode commuting by logging self-reported car, transit, walking and bicycling work trips, RideAmigos has the capacity to expand its offering to include trackable trip inputs through an API (application programming interface) connection with external user’s databases such as the MIT parking data warehouse. RideAmigos is working to design a mobile application that would perform the tasks of the Moves app tracking walking and bicycling trips that can be used for the commuter dashboard upon testing and completion. The application offers a lottery widget that can be custom designed to meet the needs of the proposed commuter dashboard. The user interface elements recommended in this chapter can be integrated into the RideAmigos platform in order to utilize the RideAmigos user profile interface as well as its underlying mapping capabilities, carpool matching and gamification elements. Figure 6-4 below shows a sample home page from RideAmigos. The home page contains badge elements, a leaderboard, as well as the capability to log trips. The employer databases can send trip and demographic information to RideAmigos automatically through the API and turn off the capability to self-report trips through their application. For more views of a sample RideAmigos application, see Appendix G.
In summary, the chapter discussed the data fields required to be passed into a stand-alone commuter dashboard that processed the inputs and displayed summarized information, but there are applications already fully developed (such as RideAmigos) that can be further customized to meet the same data visualization and lottery goals. Future work should be focused on integrating data from MIT and other employer commuting databases directly into the chosen third-party application, or to further refine a stand-alone dashboard design. Chapter 7 contains a summary, recommendations, as well as a discussion of future work on the Kendall Square employer commuter benefits value pricing project.
7. CONCLUSION AND NEXT STEPS

The goal of this research was to examine and recommend changes to the design of employer commuter benefit programs in Kendall Square, Cambridge, Massachusetts in order to reduce single-occupancy vehicle commuting. Employers are motivated to offer competitive benefits to attract employees while keeping their overhead costs low, while employees wish to spend less time and/or money commuting to their jobs.

This research provides an analysis of current commuting behavior for large employers in Cambridge as well as an analysis of current incentives used currently in both local and national organizations to promote behavior change. The thesis also presents the design for a tool to track the impacts of commuter benefit changes at the individual and employer level, as well as a series of potential commuter incentives and their expected effects on mode share.

7.1 SUMMARY

Behavioral Economics and Social Psychology

The literature reviewed here describes previous research in behavioral economics, psychological methods of motivation, and an examination of short and long term behavior changes. Some key takeaways are:

- Transition extrinsic motivations into intrinsic ones for more effective behavior change
- Experiments can be designed to promote durable behavior change using social gamification
- Follow the principles of MINDSPACE (P. Dolan M. H., 2012) when developing a behavior change experiment

TDM Nationwide and in Cambridge

Employer-based transportation demand management programs are a key method of promoting alternative modes. Incentives such as a universal access pass to transit, parking cash-out, bikeshare and carpool subsidies, and offering financial prizes in the form of a lottery were found to have a substantial effect on changing mode share. Additionally, charging for the actual cost of providing parking and transitioning from monthly to daily parking charges were found to be effective at reducing drive alone commuting behavior.

TDM in Kendall Square

Lessons learned from Portland, Seattle and Minneapolis on providing universal passes and parking cash-out options to large employers suggest that universal passes improve transit ridership in places with high transit mode share (such as Kendall Square) and that parking cash-out (or partial cash-out) options work well for employers that currently do not charge for parking, or charge very little. The
current subsidy that MIT provides its annual parkers is $1,984 while monthly transit pass holders receive only $450 per year in subsidy. Bicyclists receive a small subsidy from MIT of up to $20 per month ($240 per year) pre-tax towards qualified bicycle expenses. Walkers receive no subsidy for their commuting. The MIT Mobility Pass trial from 2010 to present provided free unlimited transit passes to a select number of employees who paid for annual parking permits. This trial set the stage for future expansion of a universal pay-per-use transit pass and resulted in a 4% reduction in parking on campus among those parkers who participated, as well as a significant increase in transit usage by participants.

MIT is choosing between an all-employee benefits change to move towards daily parking and providing universal access to transit for a low fixed fee, or implement a larger-scale experiment where the cost of transit, access to a commuter dashboard, and the cost of parking are varied to better determine the impact of these changes on the MIT employee population.

Proposed Incentives

The criteria for choosing incentives based on the characteristics of organizations include:

- Current commuting behavior (i.e., mode split)
- Size of the institution
- Extent of marketing/Human Resources capacity
- Proximity of alternatives
- Geographic location of an employer

Each factor makes certain incentives more likely to be successful, such as a large employer benefiting more from a commuter dashboard than a small employer. The proposed incentives to be considered for Kendall Square employers include an expanded universal transit pass, the introduction of daily parking rates, partial or full parking cash-out, and a dashboard (with or without a lottery prize component to further encourage commuter behavior change). An outline of the steps needed to design and perform the experiment at MIT was provided, as well as a list of other potential employers and recommended incentives to be considered for each.

Commuter Dashboard/Lottery Prize Scheme

The design for a commuter dashboard that combines individual parking, transit, bicycling, walking and carpooling data in one application was presented as part of this research. The required data fields as well as the process of displaying summarized information was included. The conceptual design itself can be developed into a stand-alone application, but there are applications already fully developed (such as RideAmigos) that can be further customized to meet the same data visualization and lottery goals. Important elements of the dashboard include: tracking parking data through the employer parking gates, tracking MBTA data through a Charlie chip in the CharlieCard, tracking bike/walk commutes through the Moves mobile app, and rewarding participation through a game that distributes cash prizes based on the amount of non-SOV commuting an individual does.
7.2 Recommendations

Incentives to consider for Kendall Square employers

Expand or introduce universal transit pass

The introduction of a universal transit pass in Portland, Minneapolis and Seattle have resulted in significant mode shift from SOV to transit, and this incentive can be tailored to the organization’s needs. In the case of MIT, a fixed price pass for each employee is the recommended approach, but other employers may wish to offer a pay-per-use pass for which each ride is at a 50% discount. Universal passes are recommended for implementation in large organizations located in urban areas with good proximity to transit and high transit mode share.

Move to daily parking rates

Daily parking rates for employees (instead of monthly or annual rates) allows employees to choose whether to pay $8-$10 per day to park, or pay nothing or a small price to take transit, bicycle, walk, or carpool. No longer considered a sunk cost, employees can have more flexibility in their commuting choices and each option is priced to promote alternative modes. Daily rates are recommended for employers that can track employee parking usage (gated lots), and can be implemented across a variety of organization sizes and locations.

Parking cash-out

Parking cash-out or partial cash-out allows employees to decide what they would like to do with a budget provided to them for commuting to work. Employees can take the cash-out amount and use it to pay for parking, transit passes or a new bicycle, but they will be charged to park each day. A full cash-out would entail that amount of the cash-out equal the amount of parking each day at work. A partial cash-out can be any amount of money such that those who park each day eventually must pay for a portion of the parking out of their own funds. Parking cash-outs are recommended for employers who lease their parking spaces who can eventually reduce the number of parking spaces they lease to save money or for those who are expanding rapidly and face parking capacity constraints. Employers of any size can participate successfully in a parking cash-out benefit, but smaller employers may be more interested in participating because it is relatively easy to administer and their total cost of a cash-out program will be smaller. This incentive can be used for organizations located anywhere, but it may be more effective where alternative modes are readily available for use. A hybrid partial cash-out could involve providing all employees with a universal transit pass and provide a very modest cash-out to bicyclists and walkers.

Implement Commuter Dashboard

The commuter dashboard allows employees to see their commuting behavior over time and compare themselves to other people who work with them or live near them. It also provides a medium through which to communicate with benefit recipients and offer lotteries and prizes that promote alternative commuting. The Dashboard is recommended for employers who have the funds to market alternative
commuting options and who have parking data available for their employees. These features make this incentive better for larger employers who are located in urban areas near many alternative modes.

*Promote events such as Bike to Work*

Smaller events can be effective at behavior change by introducing alternative commuting modes to employees who may never have considered them before in a social, fun way. Bike or Walk to Work events are particularly effective for employers who have a large percentage of their workforce living within five miles of their worksite. As over 50% of MIT employees live within five miles, indicating that promoting bicycling as a mode can increase the number of bicyclist commuters. This incentive is recommended for small organizations who can develop meaningful competition between event participant groups, as well as for those organizations in an urban area with a high proximity to alternative modes.

**Recommendations for MIT**

As a large employer with access to employee MBTA data, parking access information, and a high transit mode share, MIT should consider implementing incentives that will best promote alternative modes. MIT should implement a commuter dashboard that provides employees with information on their commutes and the opportunity to compete against their co-workers and neighbors in collecting credits towards cash prizes. MIT should also expand the Mobility Pass to each employee for $15 per month, allowing access to zero marginal cost transit and the ability to pay $8.50 per day to park. A change from annual to daily parking should occur gradually over the course of a year and the switch to daily rates will allow frequent parkers to consider taking another mode. All incentives should be heavily marketed by MIT and financial incentives provided through a new lottery and paid through the payroll system to promote non-SOV commuting.

MIT should consider implementing an all-employee incentive program instead of a sample population experiment. From an implementation perspective, it is challenging to put an experiment in place with drastic differences in employee benefits. In the randomized experimental design proposed, MIT would be providing some employees with $15 transit passes while others paid $37.50 per month for them. Other employees would receive access to participate in lotteries for cash prizes not available to all employees. The author recommends that MIT consider implementing Scenario 2 (described above and in Section 5.3.1) for all employees and measure the impact on the entire employee population in order to maintain equity among employees who will undoubtedly determine that they are being treated differently by their employer if a randomized study is implemented.

### 7.3 Future Work

The commuter dashboard has approval to be developed for the MIT community over the course of the next several months. Future work should be focused on integrating data from MIT and other employer commuting databases directly into the chosen third-party application for the commuter dashboard, or to further refine a stand-alone dashboard design.
A decision for the direction of the MIT implementation will be made by the Executive Vice President and the Parking and Transportation Committee in the weeks following the submission of this thesis. At that time, the members of the research team will either be working to implement an all-employee benefits change or a controlled experiment on a portion of the population. This decision will include which scenario was chosen and how best to proceed. If a controlled experiment is chosen, then future work will include determining participants for each experimental group and setting up a method of collecting tracked information for each participant, as well as performing heavy marketing of the experiment. If an all-employee benefits change scenario is chosen, then a new Institute-wide program needs to be developed to market the changes, and procedures must be put into place to track the results in terms of parking usage, transit usage and bicycling and walking behavior. Under all scenarios, work is required to add sensors to MIT parking lots that are currently un-gated in order to expand daily parking to all MIT employees in 2016.

In the near future, members of the research team should reach out to other Kendall Square employers and present the list of potential incentive options outlined in this research. The team should then work to integrate their employee data into the dashboard. The specific cash prize values to be integrated as part of the lottery portion of the dashboard must be determined based on the budget constraints of each employer as they are brought into the experimental design.

The findings of this research suggest that by changing the costs of commuting and providing both monetary and social incentives to employees, single-occupant vehicle commuting mode share can be reduced, even in high-transit, urban areas like Kendall Square. Introducing a combination of universal transit passes, parking cash-out schemes, daily parking rates, and commuter dashboards can improve transit, walking, and bicycling mode share for employers in Cambridge, Massachusetts.
### APPENDIX A: MOBILE APPS

Below is a table of companies associated to real-time journey planning/multi-modal transportation mobile websites or applications. This list was assembled as an examination of what was on the marketplace as of January 2014 in order to provide a background to

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Use real-time data?</th>
<th>Mode(s)</th>
<th>Audience</th>
<th>Survivable?</th>
<th>Available Offline?</th>
<th>Company URL</th>
<th>Description</th>
<th>Details</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car2Go</td>
<td>Yes</td>
<td>car</td>
<td>private car alternative</td>
<td>Yes</td>
<td>No</td>
<td><a href="https://www.car2go.com/en/austin/">https://www.car2go.com/en/austin/</a></td>
<td>company car app</td>
<td></td>
<td>Run by BMW</td>
</tr>
<tr>
<td>DriveNow (one way)</td>
<td>Yes</td>
<td>car</td>
<td>private car alternative</td>
<td>Maybe</td>
<td>No</td>
<td><a href="https://us.drivnow.com/?language=en_US&amp;L=2">https://us.drivnow.com/?language=en_US&amp;L=2</a></td>
<td>company car app</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Über</td>
<td>Yes</td>
<td>taxi</td>
<td>one-off trip-taker</td>
<td>Yes</td>
<td>No</td>
<td><a href="https://www.uber.com/">https://www.uber.com/</a></td>
<td>taxi app</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lyft</td>
<td>Yes</td>
<td>p2p</td>
<td>one-off trip-taker</td>
<td>Maybe</td>
<td>No</td>
<td><a href="http://www.lyft.me">lyft.me</a></td>
<td>p2p taxi service- mobile app</td>
<td></td>
<td>4 min avg pickup time</td>
</tr>
<tr>
<td>zimride</td>
<td>No</td>
<td>static carpool</td>
<td>private car commuter</td>
<td>Yes</td>
<td>No</td>
<td><a href="http://www.zimride.mit.edu">zimride.mit.edu</a></td>
<td>mobile website</td>
<td>You can find other people to ride with who are associated to your network</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- **Pick up** electric cars at specified locations and can return to any DriveNow location. Use DriveNow ID to lock and unlock vehicles. $12 for first 30 minutes, $0.32 for each minute after that-$30 daily maximum
- **Run by BMW**
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Use real-time data?</th>
<th>Type</th>
<th>Mode</th>
<th>Audience</th>
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<th>Company URL</th>
<th>Description</th>
<th>Details</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craigslist Rideshare section</td>
<td>No</td>
<td>static carpool</td>
<td>private car</td>
<td>one-off trip-taker</td>
<td>Yes</td>
<td>No</td>
<td>mobile website</td>
<td></td>
<td>Not so much real-time</td>
<td></td>
</tr>
<tr>
<td>Where's my MIT Bus?</td>
<td>Yes</td>
<td>bus tracking</td>
<td>bus</td>
<td>commuter, institution-specific</td>
<td>Yes</td>
<td>No</td>
<td><a href="https://itunes.apple.com/us/app/where-my-mit-bus/id461561847?mt=8">https://itunes.apple.com/us/app/where-my-mit-bus/id461561847?mt=8</a></td>
<td>mit travel app</td>
<td>Could set up similar one with Charleston information- uses NextBus data</td>
<td></td>
</tr>
<tr>
<td>Waze</td>
<td>Yes</td>
<td>traffic tracking, car trip planner</td>
<td>car</td>
<td>commuter, one-off trip-taker</td>
<td>Yes</td>
<td>No</td>
<td><a href="https://www.waze.com/">https://www.waze.com/</a></td>
<td>traffic p2p reporting app</td>
<td>Automatically updates route with unexpected delays or improvements in eta, will reroute if finds better solution</td>
<td></td>
</tr>
<tr>
<td>Carma</td>
<td>Yes</td>
<td>private ridesharing</td>
<td>car</td>
<td>commuter, institution-specific, one-off trip-taker</td>
<td>Yes</td>
<td>No</td>
<td>car.ma</td>
<td>real-time ridesharing app</td>
<td>Public-private partnerships to create &quot;virtual slugging&quot;- only available in cities with public-private partnership</td>
<td></td>
</tr>
</tbody>
</table>


Pilot program in Montreal with the idea of one-way, no reservation car sharing within a specific region. You can keep the car as long as you like and return it anywhere within the region.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Use real-time data?</th>
<th>Type</th>
<th>Modes</th>
<th>Audience</th>
<th>Survivable?</th>
<th>Available Offline?</th>
<th>Company URL</th>
<th>Description</th>
<th>Details</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avego</td>
<td>Yes</td>
<td>private ridesharing</td>
<td>car</td>
<td>commuter, institution-specific, one-off trip-taker</td>
<td>No</td>
<td>No</td>
<td>car.ma</td>
<td>real-time ridesharing app</td>
<td>Now defunct, called Carma</td>
<td>Operates in Los Angeles, Toronto, San Francisco, Washington DC, and Boston, as well as many well-known small and mid-sized transit agencies, universities and colleges including Chapel Hill Transit, RTC-Washoe (Reno), Saint John Transit, Banff Roam, MIT, Georgia Tech, UCLA, University of Maryland, and Rutgers University.</td>
</tr>
<tr>
<td>NextBus</td>
<td>Yes</td>
<td>bus tracking, train tracking</td>
<td>bus, rail, shuttle</td>
<td>commuter, students</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://www.nextbus.com/homepage/">http://www.nextbus.com/homepage/</a></td>
<td>real-time transit info</td>
<td>Has open API (open sourced)- can be implemented in other communities relatively easily.</td>
<td>Used at University of South Carolina. WMATA Metro pays ~$223,000 a year for NextBus to run</td>
</tr>
<tr>
<td>OneBusAway</td>
<td>Yes</td>
<td>bus tracking, train tracking</td>
<td>bus, shuttle</td>
<td>commuter, students</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="https://github.com/OneBusAway/onebusaway/wiki/OneBusAway-Deployments">https://github.com/OneBusAway/onebusaway/wiki/OneBusAway-Deployments</a></td>
<td>real-time transit info</td>
<td>Bikeshare app that contains multiple city's data on bikeshare, plus what routes to take on the bike in the cities, create and save bike routes</td>
<td>Uses Hubway data, B-cycle data, Capital Bikeshare data</td>
</tr>
<tr>
<td>Spotcycle</td>
<td>Yes</td>
<td>bikeshare</td>
<td>bicycle</td>
<td>tourist, commuter</td>
<td>Yes</td>
<td>No</td>
<td><a href="http://www.spotcycle.net/">http://www.spotcycle.net/</a></td>
<td>bikeshare app</td>
<td>Uses Hubway data, B-cycle data, Capital Bikeshare data</td>
<td></td>
</tr>
<tr>
<td>Madison B-Cycle</td>
<td>Yes</td>
<td>bikeshare</td>
<td>bicycle</td>
<td>tourist, commuter</td>
<td>Yes</td>
<td>No</td>
<td><a href="http://madisonbcycle.com/">http://madisonbcycle.com/</a></td>
<td>bikeshare website</td>
<td>MADISON B-CYCLE 35 Stations 225 Bikes</td>
<td>240,323 City Population</td>
</tr>
<tr>
<td>Company Name</td>
<td>Use real-time data?</td>
<td>Type</td>
<td>Mode(s)</td>
<td>Audience</td>
<td>Survivable?</td>
<td>Available Offline?</td>
<td>Company URL</td>
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</tr>
<tr>
<td>Chattanooga Bicycle Transit</td>
<td>Yes</td>
<td>bikeshare</td>
<td>bicycle</td>
<td>tourist, commuter</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>bikeshare website</td>
<td>CHATTANOOGA BICYCLE TRANSIT SYSTEM  32 Stations  300 Bikes  171,279 City Population</td>
<td></td>
</tr>
<tr>
<td>Boulder B-Cycle</td>
<td>Yes</td>
<td>bikeshare</td>
<td>bicycle</td>
<td>tourist, commuter</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>bikeshare website</td>
<td>BOULDER B-CYCLE  22 Stations  150 Bikes  97,385 City Population</td>
<td></td>
</tr>
<tr>
<td>Spartanburg B-Cycle</td>
<td>Yes</td>
<td>bikeshare</td>
<td>bicycle</td>
<td>tourist, commuter</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td><a href="http://spartanburg.bcycle.com/">http://spartanburg.bcycle.com/</a></td>
<td>bikeshare website  37,334 City Population  4 stations</td>
<td></td>
</tr>
<tr>
<td>Corral Rides</td>
<td>Yes</td>
<td>origin-destination aggregator</td>
<td>car, walk, rail, bus</td>
<td>commuter, tourist, occasional user</td>
<td>Maybe</td>
<td>No</td>
<td><a href="http://www.geotcorral.com/corral-rides">http://www.geotcorral.com/corral-rides</a></td>
<td>real-time transit app</td>
<td>Operates in SF. Takes Uber, Lyft, Sidecar, and all google options in one place. Origin and Destination</td>
<td></td>
</tr>
<tr>
<td>Instant Cab</td>
<td>Yes</td>
<td>taxi tracking, rideshare</td>
<td>car, taxi</td>
<td>occasional user</td>
<td>Maybe</td>
<td>No</td>
<td><a href="http://instantcab.com/">http://instantcab.com/</a></td>
<td>real-time cab and rideshare app</td>
<td>Only operates in San Francisco but allows online payment- uses community members and cabs on one application</td>
<td></td>
</tr>
<tr>
<td>Hailo Cab</td>
<td>Yes</td>
<td>taxi tracking</td>
<td>taxi</td>
<td>tourist, occasional users</td>
<td>Yes</td>
<td>No</td>
<td><a href="https://hailocab.com/boston">https://hailocab.com/boston</a></td>
<td>real-time cab app</td>
<td>Operates in Boston and Cambridge (as well as DC, NYC, etc)- pay by credit card</td>
<td></td>
</tr>
<tr>
<td>Transit App</td>
<td>Yes</td>
<td>origin-destination, bus tracking</td>
<td>bus, rail</td>
<td>tourist, occasional users</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://www.thetransitapp.com">www.thetransitapp.com</a></td>
<td>real-time transit app</td>
<td>Operates in 43 cities in Canada and US. Focuses solely on public transit and uses GTFS feeds to update its</td>
<td></td>
</tr>
<tr>
<td>Company Name</td>
<td>Use real-time data?</td>
<td>Mode(s)</td>
<td>Audience</td>
<td>Survivable?</td>
<td>Available Offline?</td>
<td>Company URL</td>
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</tr>
<tr>
<td>MTR Mobile</td>
<td>Yes</td>
<td>journey planner</td>
<td>rail, car</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>real-time transit app</td>
<td>Contains access to traffic information, tourist information, exit routes out of train stations and journey planner using the trains- Airport Express, Tung Chung Line and West Rail Line train schedules</td>
<td></td>
</tr>
<tr>
<td>SmartRide</td>
<td>Yes</td>
<td>bus, train tracking, train tracking</td>
<td>bus, rail, ferry</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://www.smartrideapp.com">http://www.smartrideapp.com</a></td>
<td>real-time transit app</td>
<td>Uses GTFS feeds from open data APIs for calculating nearby buses and trains to the user. No trip planning features</td>
<td></td>
</tr>
<tr>
<td>TRAFI</td>
<td>Yes</td>
<td>origin-destination aggregrater</td>
<td>bus, rail</td>
<td>commuter, tourist, occasional user</td>
<td>Maybe</td>
<td>Yes</td>
<td><a href="http://beta.marshrutai.lt/?l=en">http://beta.marshrutai.lt/?l=en</a></td>
<td>real-time transit app</td>
<td>Lithuanian Startup for combining modes in emerging markets where Google doesn't reach</td>
<td></td>
</tr>
<tr>
<td>CityMapper</td>
<td>Yes</td>
<td>origin-destination aggregrater</td>
<td>walk, bus, rail, taxi, bicycle</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td>No</td>
<td><a href="http://citymapper.com">http://citymapper.com</a></td>
<td>real-time transportatio n app</td>
<td>Operates in New York and London- combines walking stats, bike options, taxi estimates, trains and buses in one place</td>
<td></td>
</tr>
<tr>
<td>TriMet Tickets</td>
<td>No</td>
<td>transit ticketing</td>
<td>bus, light rail, commuter rail, streetcar</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td>No</td>
<td><a href="http://trimet.org/mobleticket">http://trimet.org/mobleticket</a></td>
<td>Mobile ticket purchase app</td>
<td>Buy and use tickets for transit on the app- works in Portland, OR on buses, trains, streetcar</td>
<td></td>
</tr>
</tbody>
</table>

estimates. Can download travel packs for cities to work offline
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Use real-time data?</th>
<th>Type</th>
<th>Modes</th>
<th>Audience</th>
<th>Available Offline?</th>
<th>Company URL</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinlister</td>
<td>Yes</td>
<td>private bike rental</td>
<td>bicycle</td>
<td>occasional user, tourist</td>
<td>Maybe</td>
<td><a href="https://www.spinlister.com/">https://www.spinlister.com/</a></td>
<td>With Spinlister you can rent any kind of bike from people like you anywhere in the world. It's easy and free to list your own bike, and decide whom to rent to. Spinlister connects amazing people with cool bikes from anywhere.</td>
</tr>
<tr>
<td>Ride Scout</td>
<td>Yes</td>
<td>origin-destination aggregator</td>
<td>walk, bus, rail, taxi, bicycle, bike, taxi, rideshare, car share</td>
<td>commuter, tourist, occasional user</td>
<td>Maybe</td>
<td><a href="http://ridescoutapp.com/#">http://ridescoutapp.com/#</a></td>
<td>real-time transport app</td>
</tr>
<tr>
<td>Zipcar</td>
<td>Yes</td>
<td>car share</td>
<td>car</td>
<td>occasional user</td>
<td>Yes</td>
<td><a href="http://www.zipcar.com/drtv">http://www.zipcar.com/drtv</a></td>
<td>real-time carshare app</td>
</tr>
<tr>
<td>OpenMBTA</td>
<td>Yes</td>
<td>origin-destination bus tracker, train tracker</td>
<td>bus, train, rail, ferry</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td><a href="http://openmbta.org/">http://openmbta.org/</a></td>
<td>real-time transit app</td>
</tr>
<tr>
<td>Company Name</td>
<td>Use real-time data?</td>
<td>Type</td>
<td>Mode</td>
<td>Audience</td>
<td>Survivable?</td>
<td>Available Offline?</td>
<td>Company URL</td>
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</tr>
<tr>
<td>chromaroma</td>
<td>No</td>
<td>transit game</td>
<td>train, bus, bicycle</td>
<td>commuter</td>
<td>Maybe</td>
<td>No</td>
<td><a href="http://www.chromaroma.com/">http://www.chromaroma.com/</a></td>
</tr>
<tr>
<td>ExitStrategy</td>
<td>No</td>
<td>exit locations/entrances for subway</td>
<td>train</td>
<td>commuter</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://www.exitstrategynyc.com/">http://www.exitstrategynyc.com/</a></td>
</tr>
<tr>
<td>HopStop</td>
<td>Yes</td>
<td>origin-destination aggregator</td>
<td>walk, bus, train</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="https://boston.hopstop.com/">https://boston.hopstop.com/</a></td>
</tr>
<tr>
<td>Moovit</td>
<td>Yes</td>
<td>transit tracking, public transit trip planner</td>
<td>bus, train</td>
<td>commuter</td>
<td>Yes</td>
<td>No</td>
<td><a href="http://m.moovitapp.com/English/index.html">http://m.moovitapp.com/English/index.html</a></td>
</tr>
<tr>
<td>Tripit</td>
<td>No</td>
<td>travel itinerary organizer</td>
<td>N/A</td>
<td>commuter</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="https://www.tripit.com/uhp/mobile">https://www.tripit.com/uhp/mobile</a></td>
</tr>
<tr>
<td>Embark</td>
<td>Yes</td>
<td>real-time transit planner</td>
<td>train, bus, train</td>
<td>commuter</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://letsembark.com/#home">http://letsembark.com/#home</a></td>
</tr>
<tr>
<td>Company Name</td>
<td>Use real-time data?</td>
<td>Type</td>
<td>Modes</td>
<td>Audience</td>
<td>Survivable?</td>
<td>Available Offline?</td>
<td>Company URL</td>
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</tr>
<tr>
<td>TripView</td>
<td>Yes</td>
<td>real-time transit planner</td>
<td>train, bus, rail</td>
<td>commuter</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="https://play.google.com/store/apps/details?id=com.grosoft.tripview&amp;hl=en">https://play.google.com/store/apps/details?id=com.grosoft.tripview&amp;hl=en</a></td>
</tr>
<tr>
<td>Tram Tracker</td>
<td>Yes</td>
<td>streetcar tracker</td>
<td>street car</td>
<td>commuter</td>
<td>Yes</td>
<td>No</td>
<td><a href="http://yarratrains.com.au/tramtracker">http://yarratrains.com.au/tramtracker</a></td>
</tr>
<tr>
<td>9292OV.nl</td>
<td>Yes</td>
<td>real-time transit planner</td>
<td>rail, train, bus, walk</td>
<td>commuter</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://9292.nl/">http://9292.nl/</a></td>
</tr>
<tr>
<td>BART runner</td>
<td>Yes</td>
<td></td>
<td>rail, train, bus, walk</td>
<td>commuter</td>
<td>Yes</td>
<td>No</td>
<td><a href="http://www.appbrain.com/app/bart-runner/com.do">http://www.appbrain.com/app/bart-runner/com.do</a> ugkeen.bart</td>
</tr>
<tr>
<td>Caltrain XPress</td>
<td>No</td>
<td>train transit planner</td>
<td>train</td>
<td>commuter</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="https://itunes.apple.com/us/app/caltrain-xpress/id309651502?mt=8">https://itunes.apple.com/us/app/caltrain-xpress/id309651502?mt=8</a></td>
</tr>
<tr>
<td>Company Name</td>
<td>Use real-time data?</td>
<td>Type</td>
<td>Mode(s)</td>
<td>Audience</td>
<td>Survivable?</td>
<td>Available Offline?</td>
<td>Company URL</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------</td>
<td>-----------------------------</td>
<td>------------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>-------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>WSDOT</td>
<td>Yes</td>
<td>real-time journey planner, traffic tracking</td>
<td>car, ferry</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://www.wsdot.com/information/mobile.htm">http://www.wsdot.com/information/mobile.htm</a></td>
</tr>
<tr>
<td>BestParking</td>
<td>No</td>
<td>parking locations and prices</td>
<td>car</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://www.bestparking.com/charleston-parking/">http://www.bestparking.com/charleston-parking/</a></td>
</tr>
<tr>
<td>Company Name</td>
<td>Use real-time data?</td>
<td>Type</td>
<td>Mode</td>
<td>Audience</td>
<td>Survivable?</td>
<td>Available Offline?</td>
<td>Company URL</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------</td>
<td>------</td>
<td>------</td>
<td>----------</td>
<td>------------</td>
<td>------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>ParkMe</td>
<td>Yes</td>
<td>parking locations and prices</td>
<td>car</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://www.parkme.com/">http://www.parkme.com/</a></td>
</tr>
<tr>
<td>Park Whiz</td>
<td>No</td>
<td>parking locations and prices</td>
<td>car</td>
<td>commuter, tourist, occasional user</td>
<td>Yes</td>
<td>Yes</td>
<td><a href="http://www.parkwhiz.com/">http://www.parkwhiz.com/</a></td>
</tr>
</tbody>
</table>
# Appendix B: Scenarios for MIT Employee Benefits Proposal

**Baseline Scenario**

## Table B-0-1: Baseline Scenario

<table>
<thead>
<tr>
<th>Population Size</th>
<th>Flat Fees Parking* (yearly)</th>
<th>Variable Daily Parking Cost</th>
<th>Flat Fees Transit/ month</th>
<th>Current Parking Usage/ month</th>
<th>Avg Transit Usage/ month</th>
<th>Parking Revenue (Yearly)</th>
<th>Transit Revenue (Yearly)</th>
<th>Total Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Parkers</td>
<td>2484</td>
<td>$1,506</td>
<td>$248</td>
<td>$178</td>
<td>$624</td>
<td>$3,740,904</td>
<td>$0</td>
<td>$3,740,904</td>
</tr>
<tr>
<td>Carpool/Vanpool</td>
<td>178</td>
<td>$505</td>
<td>$178</td>
<td>$15.0</td>
<td>$3113</td>
<td>$89,890</td>
<td>$0</td>
<td>$89,890</td>
</tr>
<tr>
<td>Occasional Parkers with LinkPass</td>
<td>624</td>
<td>$84.50</td>
<td>$7.70</td>
<td>$37.50</td>
<td>2.7</td>
<td>$37.50</td>
<td>$208,404</td>
<td>$280,800</td>
</tr>
<tr>
<td>Occasional Parkers, no LinkPass</td>
<td>1732</td>
<td>$84.50</td>
<td>$7.70</td>
<td>$14.0</td>
<td>3.2</td>
<td>-</td>
<td>$658,472</td>
<td>$0</td>
</tr>
<tr>
<td>LinkPass</td>
<td>3113</td>
<td>$0</td>
<td>$37.50</td>
<td>$75.00</td>
<td>$0</td>
<td>$1,400,850</td>
<td>$1,400,850</td>
<td>$1,400,850</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>848</td>
<td>$0</td>
<td>$96.09</td>
<td>-</td>
<td>-</td>
<td>$977,838</td>
<td>$977,838</td>
<td>$977,838</td>
</tr>
<tr>
<td>Bike/Walk</td>
<td>1700</td>
<td>$0</td>
<td>$0</td>
<td>-</td>
<td>-</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Total Population</td>
<td>10,679</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The advertised fee for an annual parker is $1455 in 2014-2015. The advertised fee for an occasional parker is $81. The values in this column represent the total average cost to parkers and includes those who purchase additional passes for their other vehicles at $25 per additional permit.
Scenario 1 - Annual Parking (+10%); All Others Pay $15/mo. for Occ. Parking & Mobility Pass

**TABLE B-0-2: SCENARIO 1**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Parkers</td>
<td>2484</td>
<td>$1,656</td>
<td>$ -</td>
<td>$ -</td>
<td>12.6</td>
<td>14.0</td>
<td>$3.00</td>
</tr>
<tr>
<td>Carpool/Vanpool</td>
<td>178</td>
<td>$ -</td>
<td>$4.25</td>
<td>$15.00</td>
<td>13.5</td>
<td>15.0</td>
<td>$3.00</td>
</tr>
<tr>
<td>Occasional Parkers with LinkPass</td>
<td>624</td>
<td>$ -</td>
<td>$8.50</td>
<td>$15.00</td>
<td>2.4</td>
<td>2.7</td>
<td>$75.00</td>
</tr>
<tr>
<td>Occasional Parkers, no LinkPass</td>
<td>1732</td>
<td>$ -</td>
<td>$8.50</td>
<td>$15.00</td>
<td>2.9</td>
<td>3.2</td>
<td>$8.00</td>
</tr>
<tr>
<td>LinkPass</td>
<td>3113</td>
<td>$ -</td>
<td>$8.50</td>
<td>$15.00</td>
<td>1.0</td>
<td>2.0</td>
<td>$75.00</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>848</td>
<td>$ -</td>
<td>$8.50</td>
<td>$73.59</td>
<td>1.0</td>
<td>2.0</td>
<td>$192.18</td>
</tr>
<tr>
<td>Bike/Walk</td>
<td>1700</td>
<td>$8.50</td>
<td>$15.00</td>
<td>1.0</td>
<td>2.0</td>
<td>$8.00</td>
<td>$12.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low Parking Revenue (Yearly)</th>
<th>High Parking Revenue (Yearly)</th>
<th>Low Transit Cost (Yearly)</th>
<th>High Transit Cost (Yearly)</th>
<th>Total Change in Cost to MIT (Lower Parking, High Transit)</th>
<th>Total Change in Cost to MIT (High Parking, Lower Transit)</th>
<th>Total Change in Cost to MIT (High Parking, High Transit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Parkers</td>
<td>$4,113,504</td>
<td>$4,113,504</td>
<td>$(89,424)</td>
<td>$(193,752)</td>
<td>$178,848</td>
<td>$283,176</td>
</tr>
<tr>
<td>Carpool/Vanpool</td>
<td>$122,553</td>
<td>$136,170</td>
<td>$25,632</td>
<td>$18,156</td>
<td>$50,819</td>
<td>$71,912</td>
</tr>
<tr>
<td>Occasional Parkers, no LinkPass</td>
<td>$508,792</td>
<td>$565,325</td>
<td>$145,488</td>
<td>$62,352</td>
<td>$(87,327)</td>
<td>$52,341</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>$86,496</td>
<td>$172,992</td>
<td>$(1,206,746)</td>
<td>$(1,206,746)</td>
<td>$(142,412)</td>
<td>$(55,916)</td>
</tr>
<tr>
<td>Bike/Walk</td>
<td>$173,400</td>
<td>$346,800</td>
<td>$142,800</td>
<td>$61,200</td>
<td>$234,600</td>
<td>$489,600</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ (510,675)</strong></td>
<td><strong>$ 430,621</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Scenario 2 - Annual Parking Option Maintained (+10%); All others Pay $15/mo. for Daily Parking & Mobility Pass; Allows Transit, Bike, Walk Opt-Out

**TABLE B-0-3: SCENARIO 2**

<table>
<thead>
<tr>
<th>Populatio n Size</th>
<th>Flat Fees Parking (one-time permit fee)</th>
<th>Variable Daily Parking Cost</th>
<th>Flat Fees Transit /month</th>
<th>Low Assumed Parking Usage /month</th>
<th>High Assumed Parking Usage /month</th>
<th>Low Assumed Transit Usage /month</th>
<th>High Assumed Transit Usage /month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Parkers (40% convert to Daily)</td>
<td>994</td>
<td>$ -</td>
<td>$ 8.50</td>
<td>$ 15.00</td>
<td>9.5</td>
<td>10.5</td>
<td>$ 3.00</td>
</tr>
<tr>
<td>Annual Parkers (60% remain Annual)</td>
<td>1490</td>
<td>$ 1,656</td>
<td>$ -</td>
<td>$ -</td>
<td>12.6</td>
<td>14.0</td>
<td>$ 3.00</td>
</tr>
<tr>
<td>Carpool/Vanpool</td>
<td>178</td>
<td>$ -</td>
<td>$ 4.25</td>
<td>$ 15.00</td>
<td>13.5</td>
<td>15.0</td>
<td>$ 3.00</td>
</tr>
<tr>
<td>Occasional Parkers with LinkPass</td>
<td>624</td>
<td>$ -</td>
<td>$ 8.50</td>
<td>$ 15.00</td>
<td>2.4</td>
<td>2.7</td>
<td>$ 75.00</td>
</tr>
<tr>
<td>Occasional Parkers, No LinkPass</td>
<td>1732</td>
<td>$ -</td>
<td>$ 8.50</td>
<td>$ 15.00</td>
<td>2.9</td>
<td>3.2</td>
<td>$ 8.00</td>
</tr>
<tr>
<td>LinkPass with New Parking (20%)</td>
<td>623</td>
<td>$ 200</td>
<td>$ 8.50</td>
<td>$ 15.00</td>
<td>2.4</td>
<td>2.7</td>
<td>$ 75.00</td>
</tr>
<tr>
<td>LinkPass w/o Parking (80%)</td>
<td>2490</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
<td>15.00</td>
<td>$ 75.00</td>
<td>$ 75.00</td>
</tr>
<tr>
<td>Commuter Rail with New Parking (20%)</td>
<td>170</td>
<td>$ 200</td>
<td>$ 8.50</td>
<td>$ 73.59</td>
<td>2.4</td>
<td>2.7</td>
<td>$ 192.18</td>
</tr>
<tr>
<td>Commuter Rail w/o Parking (80%)</td>
<td>678</td>
<td>$ -</td>
<td>$ -</td>
<td>$ 73.59</td>
<td>2.4</td>
<td>2.7</td>
<td>$ 192.18</td>
</tr>
<tr>
<td>Bike/Walk opt-in with New Parking (10%)</td>
<td>170</td>
<td>$ 200</td>
<td>$ 8.50</td>
<td>$ 15.00</td>
<td>2.4</td>
<td>2.7</td>
<td>$ 15.00</td>
</tr>
<tr>
<td>Bike/Walk opt-in w/o Parking (40%)</td>
<td>680</td>
<td>$ -</td>
<td>$ -</td>
<td>$ 15.00</td>
<td>$ 15.00</td>
<td>$ 35.00</td>
<td>$ 35.00</td>
</tr>
</tbody>
</table>
### Scenario 2 (continued)

<table>
<thead>
<tr>
<th></th>
<th>Low Parking Revenue (Yearly)</th>
<th>High Parking Revenue (Yearly)</th>
<th>Low Transit Cost (Yearly)</th>
<th>High Transit Cost (Yearly)</th>
<th>Total Change in Cost to MIT (Lower Parking, High Transit)</th>
<th>Total Change in Cost to MIT (High Parking, Lower Transit)</th>
<th>Total Change in Cost to MIT (High Parking, High Transit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Parkers (40%) convert to Daily</td>
<td>$958,117</td>
<td>$1,064,574</td>
<td>$143,136</td>
<td>$101,388</td>
<td>$ (437,459)</td>
<td>$ (289,254)</td>
<td>$ (331,002)</td>
</tr>
<tr>
<td>Annual Parkers (60% remain Annual)</td>
<td>$2,467,440</td>
<td></td>
<td></td>
<td></td>
<td>$ 107,280</td>
<td>$ 169,860</td>
<td>$ 107,280</td>
</tr>
<tr>
<td>Carpool/Vanpool</td>
<td>$122,553</td>
<td>$136,170</td>
<td>$25,632</td>
<td>$18,156</td>
<td>$ 50,819</td>
<td>$ 71,912</td>
<td>$ 64,436</td>
</tr>
<tr>
<td>Occasional Parkers with LinkPass</td>
<td>$154,665</td>
<td>$171,850</td>
<td>$449,280</td>
<td>$449,280</td>
<td>$ (222,219)</td>
<td>$ (205,034)</td>
<td>$ (205,034)</td>
</tr>
<tr>
<td>Occasional Parkers, No LinkPass</td>
<td>$508,792</td>
<td>$565,325</td>
<td>$145,488</td>
<td>$62,352</td>
<td>$ (87,327)</td>
<td>$ 52,341</td>
<td>$ (30,795)</td>
</tr>
<tr>
<td>LinkPass with New Parking (20%)</td>
<td>$277,110</td>
<td>$296,174</td>
<td>$448,560</td>
<td>$448,560</td>
<td>$ 108,900</td>
<td>$ 127,964</td>
<td>$ 127,964</td>
</tr>
<tr>
<td>LinkPass w/o Parking (80%)</td>
<td></td>
<td>$1,792,800</td>
<td>$1,792,800</td>
<td></td>
<td>$ (672,300)</td>
<td>$ (672,300)</td>
<td>$ (672,300)</td>
</tr>
<tr>
<td>Commuter Rail with New Parking (20%)</td>
<td>$75,616</td>
<td>$80,818</td>
<td>$241,918</td>
<td>$241,918</td>
<td>$ 29,726</td>
<td>$ 34,928</td>
<td>$ 34,928</td>
</tr>
<tr>
<td>Commuter Rail w/o Parking (80%)</td>
<td></td>
<td>$964,827</td>
<td>$964,827</td>
<td></td>
<td>$ (183,018)</td>
<td>$ (183,018)</td>
<td>$ (183,018)</td>
</tr>
<tr>
<td>Bike/Walk opt-in with New Parking (10%)</td>
<td>$75,616</td>
<td>$80,818</td>
<td></td>
<td>(40,800)</td>
<td>$ 34,816</td>
<td>$ 80,818</td>
<td>$ 40,018</td>
</tr>
<tr>
<td>Bike/Walk opt-in w/o Parking (40%)</td>
<td></td>
<td>$163,200</td>
<td></td>
<td></td>
<td>$ (163,200)</td>
<td>$ (163,200)</td>
<td>$ (163,200)</td>
</tr>
</tbody>
</table>

**Total** $ (1,433,982) $ (811,782) $ (1,210,722)
### Scenario 3 - All Pay fee for Occ. Parking & $0/mo Mobility Pass

#### TABLE B-0-4: SCENARIO 3

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Parkers</td>
<td>2484</td>
<td>$ 93</td>
<td>$ 8.50</td>
<td>$ -</td>
<td>12.6</td>
<td>14.0</td>
<td>$ 3.00</td>
</tr>
<tr>
<td>Carpool/Vanpool</td>
<td>178</td>
<td>$ 93</td>
<td>$ 4.25</td>
<td>$ -</td>
<td>13.5</td>
<td>15.0</td>
<td>$ 3.00</td>
</tr>
<tr>
<td>Occasional Parkers with LinkPass</td>
<td>624</td>
<td>$ 93</td>
<td>$ 8.50</td>
<td>$ -</td>
<td>2.4</td>
<td>2.7</td>
<td>$ 75.00</td>
</tr>
<tr>
<td>Occasional Parkers, no LinkPass</td>
<td>1732</td>
<td>$ 93</td>
<td>$ 8.50</td>
<td>$ -</td>
<td>2.9</td>
<td>3.2</td>
<td>$ 3.00</td>
</tr>
<tr>
<td>LinkPass</td>
<td>3113</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
<td>0.0</td>
<td>0.0</td>
<td>$ 75.00</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>848</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
<td>58.59</td>
<td>0.0</td>
<td>$ 192.18</td>
</tr>
<tr>
<td>Bike/Walk</td>
<td>1700</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
<td>0.0</td>
<td>0.0</td>
<td>$ 8.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low Parking Revenue (Yearly)</th>
<th>High Parking Revenue (Yearly)</th>
<th>Low Transit Cost (Yearly)</th>
<th>High Transit Cost (Yearly)</th>
<th>Total Change in Cost to MIT (Lower Parking, High Transit)</th>
<th>Total Change in Cost to MIT (High Parking, Lower Transit)</th>
<th>Total Change in Cost to MIT (High Parking, High Transit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Parkers</td>
<td>$ 3,423,449</td>
<td>$ 3,778,164</td>
<td>$ (89,424)</td>
<td>$ (193,752)</td>
<td>$ (511,207)</td>
<td>$ (156,492)</td>
</tr>
<tr>
<td>Carpool/Vanpool</td>
<td>$ 139,107</td>
<td>$ 152,724</td>
<td>$ (6,408)</td>
<td>$ (13,884)</td>
<td>$ 35,333</td>
<td>$ 56,426</td>
</tr>
<tr>
<td>Occasional Parkers with LinkPass</td>
<td>$ 212,697</td>
<td>$ 229,882</td>
<td>$ (561,600)</td>
<td>$ (561,600)</td>
<td>$ (276,507)</td>
<td>$ (259,322)</td>
</tr>
<tr>
<td>LinkPass</td>
<td>$ -</td>
<td>$ -</td>
<td>$ (2,801,700)</td>
<td>$ (2,801,700)</td>
<td>$ (1,400,850)</td>
<td>$ (1,400,850)</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>$ -</td>
<td>$ -</td>
<td>$ (1,359,386)</td>
<td>$ (1,359,386)</td>
<td>$ (381,548)</td>
<td>$ (381,548)</td>
</tr>
<tr>
<td>Bike/Walk</td>
<td>$ -</td>
<td>$ -</td>
<td>$ (163,200)</td>
<td>$ (244,800)</td>
<td>$ (244,800)</td>
<td>$ (244,800)</td>
</tr>
</tbody>
</table>

**Total**                     | **$ (2,903,278)**              | **$ (2,195,081)**          | **$ (2,461,229)**          |                                                          |                                                          |                                                          |
APPENDIX C: MARKETING MATERIALS FOR FOCUS GROUP

Let's help the Institute design future transportation and parking programs in alignment with its mission to serve the world.

Reduce future demand on valuable space for parking

Offer cost-effective commuting choices for members of our community

Respect the broader Cambridge community and our environment

Current Program:
$1455/year commuter parking
$81/year + $7.70/day occasional

With an annual 10% increase in parking charges,
Commuter parkers would pay $1600 for an annual permit, occasional $90/year and $8.50/day

Considerations for Changes:
1. Add unlimited transit (subway and bus) access for $15 per month
2. A daily rate system for parking (pay-as-you-park), rates TBD
3. Increase subsidy for commuter rail

Proposed Scenario:
At $8.50/day for parking (plus $15/mo for transit),
Commuter parkers: At 14 days per month, average commuter parker will pay $1600/year
Occasional parkers: At 5 days per month, occasional parkers will pay $690/year
Cap charges at $1600/year for all groups

Questions:
1. Are your full time parkers aware of the "mobility pass"? Do they/would they use it?
2. Does a daily rate system strike you as a reasonable alternative? What do you think the questions will be about this type of system? The daily rate? Parking space availability at all hours? An annual cap?
3. Do you know if there are people in your area that would use the commuter rail? Would a subsidy entice them? Why or why not?
4. What suggestions do you have for us for: introducing a daily rate pay-as-you-park system? Offering unlimited transit (subway and bus) passes? Commuter rail subsidies? Gathering further input? Communicating decisions on changes?

Thank you for your time
APPENDIX D: PROPOSED “DEMAND MANAGEMENT” PARKING AND TRANSPORTATION BENEFIT PROGRAM

PROPOSED “DEMAND MANAGEMENT” PARKING AND TRANSPORTATION BENEFIT PROGRAM
TRANSPORTATION & PARKING COMMITTEE-MARCH, 2015

OVERALL OBJECTIVE:

To introduce a comprehensive new employee transportation benefit program to encourage lower rates of single-occupant vehicle (SOV) commuting to MIT and reduce parking demand in anticipation of key decisions on future parking space construction.

KEY DESIGN PRINCIPLES:

- To offer a range of financial and convenience incentives to walk, bike, take public transit, and carpool more often, while maintaining the choice to drive alone and park at a reasonable, below-market rate.
- To design an approach that is comprehensive in nature, but one that can be phased in over the next year and a half.
- To improve the marketing, customer service, and analytical capabilities of the existing transportation and parking program.
- To design an overall program at a reasonable incremental cost that provides real short- and long-term benefits to MIT as an institution and to its faculty and staff.

MAJOR PROGRAM COMPONENTS:

1. A phased transition to pay-per-day (daily) parking for all from the current annual parking permit program
2. A universal MBTA bus and subway pass on the MIT ID for all program participants at a deeply discounted monthly fee (including similar further discounts for commuter rail, ferry and express bus services)
3. A new software platform that provides a key marketing tool for the program, an individualized commuting “dashboard” to track usage of different travel modes, and expanded options of “casual” carpooling

ADDITIONAL PROGRAM FEATURES:

4. An innovative “pay-per-use” MIT payment to the MBTA for all new passes (above the currently subscribed monthly unlimited use passes) to provide the mechanism to subsidize the more occasional use of transit
5. The potential “gamification” of commuting, by offering rewards and lottery prizes for each day an employee avoids using a parking space
6. Potential for new sensor technology (designed by CSAIL students) to effectively “gate” and accurately track usage of all MIT parking spaces, including those leased from off-campus owners (to be implemented over the next year)
<table>
<thead>
<tr>
<th>Current User Group</th>
<th>Proposed Change</th>
<th>Current User Charge</th>
<th>New User Charge</th>
<th>Estimated Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular “Annual” Parkers (~2500)</td>
<td>Annual Permit maintained for 2015-2016&lt;br&gt; All receive free MBTA LinkPass (and/or reduced price commuter rail tickets)</td>
<td>$1455/year</td>
<td>$1600/year</td>
<td>- 10-40% will choose daily parking - 40% of current annual parkers are paying more for annual than they would as daily parkers</td>
</tr>
<tr>
<td>Occasional “Daily” Parkers</td>
<td>All receive MBTA LinkPass (and/or reduced commuter rail tickets)</td>
<td>$81/year + $7.70/day</td>
<td>$180/year + $8.50/day</td>
<td>- 5-10% reduction of group without transit pass (people who opt-out of occasional parking due to higher monthly cost)&lt;br&gt;- Some increase in group from MBTA pass holders and bike/walk/taxi groups</td>
</tr>
<tr>
<td>- Without MBTA pass (1730)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- With MBTA pass (625)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MBTA Pass holders</td>
<td>Reduced monthly pass price; Option for daily parking for $200 one-time fee (charged to any new parkers w/o previous parking privileges)</td>
<td>$25-$37.50/mo</td>
<td>$15/month</td>
<td>- A few more full-time transit users from above groups (Annual and Occasional Parkers)&lt;br&gt;- Up to 20% opt for daily parking by paying new one-time $200 fee</td>
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<tr>
<td>- Bus and LinkPass (3115)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Commuter Rail + Others (850)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bikers/Walkers/Drop-ped Off/Uber or Taxi (1700)</td>
<td>Option for reduced price transit pass + daily parking (with one-time $200 fee for new parkers)</td>
<td>$0</td>
<td>$15/month</td>
<td>- About 40% are expected to opt-in for transit only&lt;br&gt;- About 10% are expected to opt-in for both transit and daily parking (paying one-time $200 fee)</td>
</tr>
</tbody>
</table>
TOTAL ESTIMATED CHANGE IN PROGRAM COST:

- Based on the rates shown above, total MIT costs are estimated to range from $815,000 to $1,435,000 above current year program costs (See spreadsheet on next page for Institute cost sensitivity to selection of final rates for next year)
- An additional $300,000 should also be budgeted for 1st year marketing, IT and administrative costs, of which $150,000-$200,000 will likely be a continuing cost after year one
- The highest costs shown imply a 10% reduction in annual and daily parking usage; the lowest costs reflect very little change in parking

PROGRAM BENEFITS:

TO MIT:

- A 10% reduction in average parking demand translates into about 300 future underground parking spaces that will not have to be built for about $125,000 per space
- Annually over their 39-year projected life, these new spaces are estimated to cost at least $2,505,000/year^2

TO INDIVIDUAL EMPLOYEES:

- All alternative mode users will receive more cash each month in their paycheck and some will forego the purchase or replacement of an automobile, substantially increasing their standard of living

MIT can be proud to sponsor one of the most innovative, sustainable, and environmentally-friendly commuter benefit programs in the country, while maintaining maximum choice and flexibility for its employees

OTHER SUGGESTED INCENTIVES NOT YET INCLUDED:

- Remote satellite parking with MIT shuttle buses (Cost TBD)
- New subsidies for MBTA parking charges ($200,000-300,000/year)
- Reduce near-in Zones 1 & 2 Commuter Rail passes to match LinkPass charge (Cannot implement now since Charlie IDs cannot yet be read on Commuter Rail and billed as pay-per-use)

NEXT STEPS:

- Approval of program and supplemental budget
- Decide on final rates for all program components
- Immediate engagement of IT staff to evaluate 3rd party marketing and dashboard software
- Evaluate planned tests of new parking sensor technology
- Plan phase-in of daily parking option by lot (for 2015-16 and 2016-17)

---

^2 $8,350/space/year based on a 39-year depreciation ($3,205), interest on a 40-year mortgage at 4% ($3,144), and FY14 O&M costs plus 10% ($2,015)
### SENSITIVITY ANALYSIS FOR COST OF PROGRAM UNDER VARIOUS RATE SCENARIOS

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Mobility Pass Cost</th>
<th>Daily Parking Rate</th>
<th>Annual Parking Rate</th>
<th>Low Parking, High Transit</th>
<th>High Parking, Low Transit</th>
<th>High Parking, High Transit</th>
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<tr>
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<td>1760</td>
<td>(826,907)</td>
<td>(181,069)</td>
<td>(580,038)</td>
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</table>

The cost of the three variables was varied +/- 10% and then entered into the model.

- **Our recommended scenario**
- **Other possible, reasonable scenarios based on keeping the Annual Parking Rate increase at 10%**

Transit usage was measured over six months between October 2013 and March 2014. Parking usage was measured for four gated garages and those assigned to those garages.
APPENDIX E: MBTA FARE TYPE CODES AND PRICING DOCUMENT

MBTA FARE CODE TYPES
Fare type codes to be used in the “tickettypeid” field for the Dashboard.

202000100;"Bus Monthly Adult"
302300101;"CR Monthly Pass Adult Zone 1a"
302300102;"CR Monthly Pass Adult Zone 1b"
302300103;"CR Monthly Pass Adult Zone 1"
302300104;"CR Monthly Pass Adult Zone 2"
302300105;"CR Monthly Pass Adult Zone 3"
302300106;"CR Monthly Pass Adult Zone 4"
302300107;"CR Monthly Pass Adult Zone 5"
302300108;"CR Monthly Pass Adult Zone 6"
302300109;"CR Monthly Pass Adult Zone 7"
302300110;"CR Monthly Pass Adult Zone 8"
302300111;"CR Monthly Pass Adult Zone 9"
304200101;"CR 10 Ride Adult Zone 1a"
304200102;"CR 10 Ride Adult Zone 1b"
304200103;"CR 10 Ride Adult Zone 1"
304200104;"CR 10 Ride Adult Zone 2"
304200105;"CR 10 Ride Adult Zone 3"
304200106;"CR 10 Ride Adult Zone 4"
304200107;"CR 10 Ride Adult Zone 5"
304200108;"CR 10 Ride Adult Zone 6"
304200109;"CR 10 Ride Adult Zone 7"
304200110;"CR 10 Ride Adult Zone 8"
304200111;"CR 10 Ride Adult Zone 9"
620000100;"Transfer Flex Adult"
605200100;"MBTA Transfer Bus/Subway"
605100100;"MBTA Transfer Subway/Bus"
602600100;"Monthly Commuter Boat Pass"
602800100;"Monthly Link Pass"

PRICING DOCUMENT SAMPLE

<table>
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<tr>
<th>Code</th>
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<th>Unit</th>
<th>Price</th>
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<td>OCP</td>
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<td>DOP</td>
<td>Daily Occasional Parking fee</td>
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<td>Carpool Parking fee</td>
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<td>Period</td>
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<tr>
<td>MOB</td>
<td>Mobility Pass without occasional parking</td>
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<td>Mobility Pass with occasional parking</td>
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### APPENDIX F: CODE LISTS FOR DEMOGRAPHIC INFORMATION

#### MIT Department Codes

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<th>Department/Program Description</th>
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<tr>
<td>AR</td>
<td>Architecture</td>
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<td>AS</td>
<td>Center for Advanced Studies</td>
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<td>CE</td>
<td>Civil &amp; Environmental Engineering</td>
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<td>CF</td>
<td>Community Fellows</td>
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<td>General Science &amp; Engineering</td>
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<td>Management (both graduate and undergraduate)</td>
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</table>
Sample Size Calculation

We wish to estimate the aggregate mode split for each group over the course of a season, i.e. the proportion of days parked, the proportion of days commuting by transit, and the proportion of days commuting by other modes, for each employee category, over the course of the fall term. Table I shows the number of employees by category. We want these estimates with an error tolerance $d$ of $\pm 2\%$ at a 95\% confidence level.

Table 1: Number of Employees By Category

<table>
<thead>
<tr>
<th>Category</th>
<th>Population Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Parkers</td>
<td>2484</td>
</tr>
<tr>
<td>Occasional Parkers without LinkPass</td>
<td>1732</td>
</tr>
<tr>
<td>LinkPass &amp; Commuter Rail</td>
<td>3961</td>
</tr>
<tr>
<td>Bike &amp; Walk</td>
<td>1700</td>
</tr>
</tbody>
</table>

To state this more precisely, let $y_{ij} = 1$ if person $i$ parks on day $j$, and 0 otherwise. Over a study period of $D$ days,

$$ p_i = \frac{\sum_{j=1}^{D} y_{ij}}{D} \tag{1} $$

is the proportion of days parked for person $i$. We regard each $p_i$ as an observation. We wish to estimate the mean proportion of days parked across the population of each employee category.

$$ \bar{p} = \frac{\sum_{i}^{n} p_i}{n} \tag{2} $$

is an unbiased estimator of this quantity, where $n < N$ is the number of employees in the sample, and $N$ is the total number of employees in the category, as shown in Table I. We assume that $\bar{p}$ is normally distributed (based on the central limit theorem). Its standard error is

$$ \sigma_{\bar{p}} = \frac{\sqrt{N - n}}{\sqrt{n}} \frac{S}{\sqrt{n}} \tag{3} $$
We want to estimate \( p \) with an error tolerance \( d \). Hence
\[
d = t\sigma_p = t\sqrt{\frac{N-n}{N}} \frac{S}{\sqrt{n}}
\] (4)
where \( t \) is the number of standard errors corresponding to our desired confidence level and \( S \) is the standard deviation of \( p \). Solving for \( n \),
\[
n = \frac{t^2 S^2}{d^2 + \frac{t^2 S^2}{N}}
\] (5)

This equation gives us the minimum number of employees that should be sampled for each category, given a confidence level, an error tolerance \( d \), a population size \( N \), and a standard deviation \( S \).

We want to estimate \( p \) with an error tolerance \( d \) of \( \pm 2\% = \pm 0.02 \) at a 95% confidence level, so we let \( t = 2 \). From a previous sample of observations, we estimated \( S \approx 0.24 \) for annual parkers and \( S \approx 0.20 \) for occasional parkers. We do not have data to estimate the variability in the proportion of days parked across employees for other categories. For the purpose of determining required sample sizes, we will assume \( S = 0.25 \) for all categories.

For example, the required sample size for annual parkers is
\[
n = \frac{2^2 \cdot 0.25^2}{0.02^2 + \frac{2^2 \cdot 0.25^2}{2484}} = 499.4 \approx 500 \text{ employees}
\] (6)

Table 2 shows the minimum required sample sizes by category. A sample of at least this size should be used to estimate the proportion of days parked for each category-treatment combination, for the given error tolerance and confidence level.

<table>
<thead>
<tr>
<th>Category</th>
<th>Minimum Required Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Parkers</td>
<td>500</td>
</tr>
<tr>
<td>Occasional Parkers without LinkPass</td>
<td>460</td>
</tr>
<tr>
<td>LinkPass &amp; Commuter Rail</td>
<td>540</td>
</tr>
<tr>
<td>Bike &amp; Walk</td>
<td>457</td>
</tr>
</tbody>
</table>
8. BIBLIOGRAPHY


Levin, A. (2013, 9 2). *Stanford has avoided $100,000,000 in parking structures over the last decade.* Retrieved from Peninsula Transportation Alternatives: http://peninsulatransportation.org/stanford-has-avoided-100000000-in-parking-structures-over-the-last-decade/


MIT Transportation and Parking Committee. (2015, 4 1). *MIT Transportation and Parking Committee Transportation Objectives*. Cambridge, MA.


Tribone, Dominick & Salvucci, Frederick. (2014, November 18). e-mail message to author. Boston, MA, USA.


