Evaluating Online Surveys for Public Transit Agencies Using a Prompted Recall Approach

by

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Abstract

Public transit agencies have traditionally relied on manually collected customer surveys to understand travel behavior and customer satisfaction. With formerly manually collected data such as ridership and running times now being automatically collected, there exists an opportunity to simplify surveys using this automatically collected information. This thesis evaluates an online approach to conduct customer surveys at a public transit agency by linking prior trip history into the survey. It also tests the prompted recall survey approach, where the personalized survey displays a prior trip segment and asks about the journey made by the respondent. The Massachusetts Bay Transportation Authority (MBTA), Boston's public transit agency, was used as a case study to develop a customer panel and test the online survey approach with prompted recall.

The research showed that verifying a trip was made in the previous week significantly increased the chances of survey response having an associated trip record. Confirming that a recent trip was made by the respondent increased the rate of matching surveyed journeys to fare transaction data from 26.7% of individuals with no recent trip to 64.2% for individuals with a recent trip. Prompted recall had a slightly higher match rate of 67.3% of individuals, but the rate of partial matches using the prompted recall approach was significantly higher at 88%. Some missed matches may be due to inaccurate or incomplete records in fare transaction records, and solutions to these issues may increase the percentage of matches through the prompted recall approach. This result shows promise for transit agencies that may look to target surveys towards individuals using specific lines or routes. The success of this approach was primarily due to the construction of the survey, which allowed for previous trip records to be analyzed prior to subsequent survey distribution, and therefore should be used as one way to increase the quantity and quality of survey responses.

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Chapter 1

Introduction

Public transit agencies have traditionally conducted passenger surveys using human survey administration to understand customer-centric issues such as passenger behaviors and attitudes as well as ridership loads, fare payment types, and ridership origin/destination patterns. In order to collect a statistically valid response, a large staff requirement is needed for deployment at all stations and routes to collect responses such that all groups and trips are appropriately represented. These large resource-intensive undertakings generally result in either focused surveys with limited scope or a lower frequency of surveys being conducted (Schaller, 2005). Other forms of passenger feedback occur at public hearings such as when a transit agency proposes a major service or fare change, but these forms of feedback relate to specific policies rather than gathering ongoing information for service evaluation. More recently, with the advent of automated fare collection (AFC) and automated vehicle location (AVL) systems, information traditionally collected manually through passenger surveys and station counts such as ridership, passenger counts, and on-time performance are now automatically collected. These automated forms of data, while providing valuable information to the agency, still cannot provide customer-based feedback such as passenger comfort or satisfaction. This research analyzes whether this automatically collected information is able to simplify the approach to surveying customers by public transit agencies, and if so, improve the quality of responses collected by such surveys to better capture the customer attitudes and perceptions of the services they use.

1.1 Motivation

The Massachusetts Bay Transportation Authority (MBTA) has conducted two large system-wide travel surveys through the Central Transportation Planning Staff (CTPS). The first was conducted over a seven year period from 1993 to 2000 and was more recently updated in 2008 and 2009. Surveys were manually distributed onboard trains and buses to collect data "not easily obtained through other means," such as age, gender, income, race, and ethnicity. Trip-specific data was also collected, focusing on origin, destination, purpose, and service quality (CTPS, 2010). These large scale surveys were infrequent due to their large costs and sampling requirements, but provided a wealth of information on ridership patterns and trends that influence future service plans. In addition to the large scale origin-destination surveys, the MBTA begun conducting smaller online surveys that ask for feedback on specific rider issues. Most recently, the agency collected 17,000 responses requesting feedback on a redesign of the system map of the transit system, with other past surveys soliciting input on baby stroller policies for the subway system and seating configurations on Red Line vehicles. These surveys are designed for quick feedback from a variety of users but are often limited in the scope of questions asked.

The past has shown that large-scale, manually-administered surveys have large benefits but high costs, both in terms of fiscal and human resources needed to administer, collect, and process the survey results. As a result, results are often limited to a subset of trips that are surveyed and generalized, which may not capture the full range of travel or types of passengers using a transit system, reducing the effectiveness of the survey. The increasing usage of online surveys and automated data collection by transit agencies can reduce the cost of collecting feedback, but recalling previous history may result in a lower quality of data compared to surveys conducted on-board vehicles. The "prompted recall" approach provides the opportunity to improve the data collection process by prompting the respondent with a time and location of boarding a vehicle or entering a station that can be obtained from individual fare transactions. By providing information about a previous trip, it can be hypothesized that respondents will recall more information about this specific trip rather than a generalized trip. In addition, the ability to have a panel of potential survey respondents online with actual trip records can aid in reducing the time spent distributing, returning, and processing passenger surveys. Rather than having staff manually distribute forms to passengers on a bus or subway car, passengers with fare records on a

specific route or trip can be contacted via email and surveyed, providing rapid route-specific feedback. The increased speed and potential targeting of survey respondents allows for the agency to quickly understand and respond to rider concerns, further enhancing the effectiveness of this survey approach. Even if traditional surveys are not completely displaced in the future, the ability to survey certain groups online and supplement such a study with in-person data collection will improve the efficiency of surveying passengers to collect comprehensive customer feedback.

1.2 Objectives

This research aims to improve the quality and quantity of surveys conducted by public transit agencies through this online survey approach. As such, the primary objectives of the research are the following:

- **Validate the utility of conducting customer satisfaction surveys online using customer panels in public transit.** Origin-Destination (OD) surveys are still typically conducted on board vehicles to gather customer feedback. This often results in a sample of individuals that may or may not be consistent across a time series, increasing the likelihood for error in conducting analyses comparing two surveys. With several transit agencies experimenting in building customer survey panels, this research aims to verify the utility of moving customer satisfaction and OD surveys to an online format. The ability to conduct these surveys online after trips have been conducted will reduce of the cost of distributing these surveys and, combined with increases in sample size, can aid transit agencies in responding to rider concerns and increase the amount of feedback provided to the transit agency. Another goal of this research is to confirm the ability to generate and use repeatedly a customer panel to conduct surveys in public transit. This allows for individuals to be quickly contacted after a completed trip and provides the transit agency with an ongoing pool of individuals to complete surveys.

- **Determine whether providing prior trip information in surveys can improve the quality of the survey response.** Conducting the survey online after a completed trip has advantages of collecting more information, but the increased time between the completed trip and the survey response may result in a lower quality of response. This research looks at whether providing infor-

mation in the survey on a previous trip segment can aid in memory recall. If this step is successful and able to be linked to other automatically collected records, then transit agencies have a powerful tool for collecting specific feedback from individuals who use the service. Agencies will be able to pinpoint specific trips or routes that warrant further analysis and only survey those individuals based on their specific travel.

- **Confirm the representativeness of the online panel.** Currently, this research recruits people to join the customer panel using convenience sampling. The analysis will focus on comparing the convenient sample of panel respondents, general MBTA riders, and the Greater Boston population to understand what differences exist in usage and demographics. Through comparisons at the mode-based and location-based levels, geographic areas and lines that are under-represented in the panel group can be improved in the future through more targeted promotion and advertising.

1.3 Methodology

This research uses the MBTA as a case study to test a new online survey approach. A customer panel is built through an initial recruitment survey to collect information on passengers and their associated transit fare card (CharlieCard), as no current database of these two sources of information exists. This initial survey is conducted online and advertised through various media such as Twitter, in-vehicle advertisements, and T-alerts, a program that sends personalized delay notifications to mobile devices, to collect emails and CharlieCard numbers, which provide the method for followup surveys, including analysis of individual trip history prior to survey distribution and the matching of trip records to an individual survey response after survey completion. The initial signup survey also gathers information on race, gender, household vehicle availability, and smartphone usage, which may be categories used to refine future survey distributions. This information is then combined with MBTA provided fare collection transactions of the surveyed individuals to divide the panel into two subgroups. These groups are defined as individuals with at least one recorded trip one week prior to survey distribution (Linked) and individuals without any trip taken in the week prior (General - Unlinked). The group with recorded trips is further divided into another two groups: a control group that completes a survey with no information provided (General - Linked), and a group that is surveyed ask-

ing about a specific trip previously made on the card number provided (Prompted Recall), to determine whether prompted recall improves the response of the survey. This analysis is conducted each time a survey is distributed such that an individual may belong to different groups based on his or her usage in the previous week.

Customer satisfaction surveys are then distributed to a subset of each of the three groups in a controlled fashion, with a random sample of respondents to the initial recruitment survey in each usage group receiving the survey. This survey asks respondents to answer questions about a specific journey, including origin, destination, purpose, and any available alternatives to using public transit to make this trip. For individuals in the Prompted Recall group, the survey gives information about a specific trip segment made on the MBTA using the CharlieCard number provided in the recruitment survey. In addition, this survey asks passengers about attitudes and perceptions of public transit, as well as to give a rating of their journey and the transit agency as a whole. This research hypothesizes that the extra information presented to the respondent will help improve the response quality of a previous trip made, increase the response rate compared to not providing any information, and provide more complete and accurate information compared to no provided information. The survey itself is analyzed to see whether the online survey approach can gather a similar quality of results to what is done using onboard surveys in terms of the information collected. Results are analyzed among the three groups to see if any significant differences can be seen in the completion rate, rating of the trip, rating of the agency, and other demographic metrics. Lastly, trip segments are matched back to AFC records to see what percentage of trips occurred on the CharlieCard number provided either in the initial survey or in the customer satisfaction survey.

1.4 Thesis Organization

Chapter 2 presents past research in developing and conducting passenger surveys in public transit, compares cross-sectional surveys to longitudinal surveys, and discusses improvements to survey design using automated sources of data. Chapter 3 discusses the recruitment survey instrument used at the MBTA, including specific design elements and the results from this initial survey. Chapter 4 analyzes the follow-up customer satisfaction survey, focusing on which information is particularly valuable to the transit agency. Chapter 5 delves further into the customer satisfaction survey by analyzing the reported trips made in the survey and comparing these trips to

the surveyed trips recorded through AFC data at the MBTA. This information will determine whether the prompted recall approach can assist in identifying individuals for specific targeted surveys. Finally, Chapter 6 summarizes the thesis and identifies future work that can build upon this research.

Chapter 2

Literature Review

Passenger surveys are a common way that public transit agencies collect feedback about their services. Public transit agencies currently survey passengers for several reasons, including market research to understand passenger travel patterns and to perform both long- and short-range planning. These surveys also serve some agencies' efforts to have transit be more customer focused, by providing communication on ongoing programs and soliciting comments to improve the customer experience (Potts, 2002). These surveys can be conducted using a variety of distribution media, including traditional surveys conducted on board vehicles or in stations, mail, telephone, or more recently, through the internet. Onboard vehicle surveys are most consistently used, with 96% of surveyed transit agencies having conducted an onboard survey in 2002-2004 (Schaller, 2005). These are primarily used for origin-destination purposes, as respondents are more likely to recall and provide this information while making the trip. For longer term planning at a regional level, agencies typically conduct a household travel diary survey. These surveys, sometimes combined with in-person interviews, ask people to record all trips made on all modes for several days in a travel diary. The advantages of this survey method include capturing trips of all types, not just public transit, as well as understanding complete trips, rather than one specific segment of a trip.

This research aims to expand the ability for transit agencies to conduct online surveys by integrating automatic fare collection (AFC) data into an online customer satisfaction survey. By presenting prior information about a trip made on a bus or subway line, it is hypothesized that the survey response can be improved both in quantity

and in quality beyond providing no information. This chapter first discusses different surveys conducted by transit surveys, summarizes past research in conducting panel surveys, and compares studies integrating manual survey data collection with automatically collected data sources.

2.1 Methods of Conducting Public Transit Surveys

Public transit agencies traditionally have conducted surveys onboard vehicles and in stations. These typically consist of staff administering surveys in the system and collecting these responses while the individual makes the journey. A survey of public transit agencies showed that in past onboard surveys, response rates of onboard surveys range between 13 and 90 percent, with the average response rate at 50 percent (Schaller, 2005). This sample of 29 agencies on average distributed 23,400 surveys, of which on average 9,100 were returned. This often is done at great cost, with staff needing to administer and retrieve each individual survey distributed. Further costs are incurred with data entry, which also slow the ability for transit agencies to use this information. As a result, the ability to conduct surveys using alternate methods becomes an appealing proposition for transit agencies.

The growth of the internet has allowed surveys to move online, with email surveys first appearing in the 1980s and web-based surveys in the 1990s (Schonlau et al., 2002). As a result, several studies have looked at comparisons between conducting surveys online and through traditional means. Online surveys have the ability to collect a large sample more quickly at a lower cost compared to traditional surveys. They also allow for specific questions to be required to be completed and in a specific order (Evans and Mathur, 2005). However, Evans notes that these surveys online may be perceived as spam, be unrepresentative of the greater population, and impersonal compared to surveys conducted over the phone or in person. These disadvantages can be neutralized through clear wording and personalized email links to complete the survey. Response rates in online surveys typically are lower than mail surveys, with the difference being on the order of 10 percentage points (Kaplowitz et al., 2004; Shih and Fan, 2008). Online responses are collected more quickly, however, with one study showing an average time between survey distribution and response at 5.97 days, which is 10.5 days or 43 percent less than an equivalent mail distribution (Yun and

Trumbo, 2000). While a fewer percentage of individuals may respond to the survey, responses that are received are received more quickly.

Web based survey techniques are growing in public transit, with 39 percent of transit agencies surveyed in 2006 reported using a web survey in some form (Spitz et al., 2006). With the growing use of internet surveys, there exists an opportunity to conduct surveys online that were traditionally collected through onboard surveys. With onboard surveys having higher costs, increased staff requirements, and smaller sample sizes, the ability to use online surveys for public transit may allow for better information to be collected.

2.2 Conducting Public Transit Surveys Through Customer Panels

There are two primary ways to conduct surveys over time: a cross-sectional survey samples people randomly each time a survey is needed, while a panel or longitudinal survey samples a select group of individuals multiple times over the survey period. Panel surveys are advantageous for several reasons: Kitamura (1990) notes that sampling the same individuals over time allows for an easier statistical analysis in estimating changes. In addition, changes in behavior by individuals are directly observed, reducing the probability that variations are attributed to differences in the samples drawn from the population. Panel surveys also allow for the costs of recruiting individuals to complete surveys to be spread out over multiple survey periods. However, disadvantages of panel surveys include the loss of panelists from various factors such as survey fatigue, non-response in subsequent surveys, and changes in response location resulting in non-representativeness of that individual in the sample (Lee, 2003). Increasing response rates can be achieved through incentives such as lotteries; this effect is most pronounced in the first follow up survey. As users are more likely to respond when offered an incentive, these individuals essentially self-select and would be more likely to complete subsequent surveys. This positive effect from the first survey does carry over to subsequent surveys, resulting in increased response rates overall (Göritz and Wolff, 2007). Given the constant erosion of panel members through attrition, new panel members can be added to "refresh" the panel and maintain sample size to reflect the demographics of an area (Coffel, 2013). However, the panel members must not only be "enthusiastic" regular customers but also include

individuals from a variety of backgrounds to make the panel successful.

Panel surveys in transportation have grown in popularity over the past 25 years, and are excellent ways to evaluate the impact of changes in transportation systems or planning projects. These have been used in evaluating fare changes, understanding travel patterns in specific areas, or impacts of new technologies (Kitamura, 1990). In public transit, panel surveys are predominantly used to gauge changes in rider attitudes, customer satisfaction, marketing, public input on planning projects, and evaluating agency actions. This, combined with online surveys, allows for more immediate survey distribution and response to understand direct changes in customer behavior (Coffel, 2013).

Currently two agencies as of this writing are known to maintain an online panel survey: New Jersey Transit (NJ Transit) and GO Transit of Toronto, Canada. These two agencies have a panel of passengers who have provided their email address and are willing to be contacted on a regular basis.

NJ Transit has significant experience with using a customer panel to gather feedback from passengers. The first foray into customer panels began in 2002, where NJ Transit implemented an online rail panel to gather customer feedback. Advertisements in stations, onboard vehicles, and through crew announcements were used to attract respondents over the summer of 2002, and goals for responses at each station were set based on system ridership. Overall, approximately 12,000 commuter rail riders were surveyed every three months to provide monthly customer satisfaction data to NJ Transit (Spitz et al., 2004). Origin-Destination data was collected through map-based geo-location or through street addresses and connected to scheduled commuter rail trips through the online survey interface. The combination of the boarding station, alighting station, and train information was used to help understand where trains were overcrowded and where the agency had improved or needed to make improvements. More recently, in 2011 NJ Transit started a new "Scorecard" initiative to understand how the agency performs using customer-facing metrics system-wide (NJ Transit, 2014). The panel was developed using customer email lists from different departments, and NJ Transit passengers are encouraged to sign-up for the panel online. The agency conducts a quarterly survey asking customers about 41 different service characteristics, including facility quality, vehicle comfort, and trip attributes. The online portion of the panel survey is supplemented with in-person intercept surveys to ensure that all segments of ridership are represented, including those without access to the internet. In their most recent reporting period of February 2014, ap-

proximately 24,000 people responded to the survey, representing 5.2 percent of daily ridership. This survey allows the agency to both identify areas for improvement and to show how customers have responded to any changes.

GO Transit is the commuter rail operator in Toronto, Canada. They began their recruitment of a panel of participants online in November 2010 as part of their "Passenger Charter" promise to riders to provide a comfortable and pleasant journey (GO Transit, 2014). The online panel survey allows for customer feedback on changes to the system and to specific policies, as reflected in improved customer satisfaction of the system. Since the inception of the panel survey, over 50 surveys have been distributed to this group, which currently consists of 7,100 panelists. Over the past three years, 54,000 responses have been collected using this method. These surveys range from the annual customer satisfaction survey asking about trip behavior to specific operator issues and specific surveys. The agency also provides an incentive to complete the survey, with the most recent survey offering a lottery to win one of 3 $75 fare vouchers.

Both of these agencies use customer panels as a response to help improve public transit service through identifying actionable items. However, no calculation is done to confirm the representativeness of this panel, as both agencies construct this panel using a "convenience sample" method. Self-selection biases are likely to be present here, as individuals who are motivated to give feedback are more likely to sign up than the general population. As a result, these panels may not be truly representative of the system, but representative of those who value improving public transit.

2.3   Combining Automatically Collected and Manual Survey Data

Origin–destination surveys are important sources of information to understand ridership behavior, but the large cost involved in conducting these surveys make frequent surveying prohibitive. Conducting surveys after trips have been made reduces the quality of the data, as respondents typically underreport travel made by 20–25% (Stopher et al., 2007). Given the move by transit agencies towards more automated processes in several areas such as fare collection and ridership counts, surveys may be simplified through these sources of data and the advancement of technology. From the respondent's point of view, surveys are simplified through reduced numbers of

questions. The agency, however, still receives an equal amount of information compared to the original survey. Several approaches have been developed to increase the amount of data available to both the agency and to survey respondents. Using the information provided by GPS and smart card records, these surveys now may be able to enhance the survey response or simplify the survey for the respondent. This section describes prior research conducted to combine these automatically collected sources of data to improve surveys.

2.3.1 GPS Studies

One relatively new method to augment household travel surveys is to use Global Positioning System (GPS) data. By having users carry a device either on their person or in their vehicle, a user's daily movements can be recorded precisely, and questions can be asked about trips made over a period of time. Travel surveys utilizing GPS units have been conducted in the United States, the Netherlands, and Australia to record individual travel. (Stopher and Greaves, 2007). The main use of the GPS data is to correct for underreporting trip rates in household diaries (Auld et al., 2009). Further research using GPS provided a better understanding of which trips are specifically being underreported, and introduced the first travel survey using a prompted recall approach (Wolf et al., 2004). Using GPS also improved the underreporting of trips to only 10 percent of actual trips made, which is much lower than other studies in cities such as Austin and Los Angeles. Deriving trip purpose and trip mode can be done using algorithms and geographic information systems (GIS) to pinpoint where trips originate and end. Given the user's home and work, these trips can be easily determined, and account for 55 percent of all trips, leaving a much smaller number to be determined as other purposes.

Stopher et al. (2007) conducted a study using the Sydney Household Travel Survey and using GPS to increase the accuracy of trip reporting. In the experiment, 465 trips were analyzed using GPS records from 59 households and compared to the travel survey. The study noted that frequent travelers and those traveling after 17:00 were likely to under-report the number of trips made, and that short trips were typically not included compared to longer trips. However, matching trip records resulted in 86% of trips being matched to within 12.5 minutes of the actual start time, but trip records generally over-reported both travel time and trip distance.

Bohte and Maat (2009) have also integrated travel diaries with GPS in the Netherlands by combining GPS logs with maps developed using GIS. Respondents were then asked to validate the trips through an online map interface. While GPS provided reliable data on trip patterns, the mode and purpose of these trips taken are not always correctly inferred. The validation stage remained difficult for users, with 60 percent of users finding it difficult to check and update trips. This GPS-based survey had similar modal splits and trip purposes to the traditional household survey, but overall more trips were recorded compared to the traditional survey, resulting in the ability to collect information on trips that would not be otherwise reported.

GPS has been tested as a substitute for manual surveys, but issues arise in terms of biases between those who are willing to participate in GPS studies and those who are not. Bricka and Bhat (2006) note that respondents in household travel surveys who self-selected to participate in the GPS study tended to have higher incomes which may influence the reports of trips completed by the respondent. However, it should be noted that any survey will have some form of non-response bias. Errors from using GPS to replace surveys include individuals forgetting to carry the GPS unit on trips, technological issues with the start of trips prior to a GPS signal lock, and positioning errors in urban environments or through tunnels. These issues all reduce the accuracy of trips shown through GPS reporting, which may result in an under-reporting of trips (Bricka et al., 2012). Overall, GPS tracking should not replace travel surveys but focus on supplementing the user with information to increase the ease by which surveys are completed.

2.3.2   Smart Card Studies

The adoption of smart cards in many public transit systems give agencies the access to large amounts of information, including personal travel data over large timespans. While surveys only reach a subset of the population, smart cards provide the ability to analyze a much larger sample group over a longer period of time to develop travel behavior patterns (Bagchi and White, 2005). Alfred Chu and Chapleau (2008) note that smart cards offer complete travel information as opposed to a small sample, as the information on all transit usage by an individual can be collected from automated data. Smart cards also allow for trip histories to be constructed over a much larger time scale, allowing for patterns at an individual level to be built without needing individuals to complete extensive surveys, reducing survey fatigue. The utilization of

smart cards also solves many of the issues presented when using GPS to supplement or replace surveys, as individuals are much less likely to forget carrying a transit pass, and vehicles typically run on fixed routes. However, using smart cards may restrict the related user data available for linking to public transit trips. With this caveat, smart cards can replicate many of the functions of a household survey, such as analyzing the usage of boarding locations, boarding times, and the route choice. However, Chu mentions that alighting stops, alighting times, trip purpose, and demographic information are still not recorded on smart cards but still necessary for proper analysis. Surveys are still needed to supplement this information in many cases.

Attempts have also been made to match smart card data to travel diary data using archived records from each source. Riegel (2013) studied the rate of matching London Travel Demand Survey (LTDS) journeys specified by individuals and the individual's associated Oyster card. She found that of approximately 4,000 people studied over a nine month period in 2011 and 2012, only 22% of the individuals in the sample had matching smart card records to survey results. When looking specifically at people who had reported public transit trips, only 44% of the sample had perfectly matching survey records and fare transactions. Issues arose in misreporting journeys made or under- or over-reporting trips made in the system. In addition, there were inaccuracies in the comparison of the journey start time between survey results and fare records, with an average difference in start time of over 60 minutes. Overall the household survey responses overestimated the frequency of public transit use when compared to the smart card usage, and the study suggests that integrating smart card information to the household interview survey earlier in the process of conducting the survey will yield better results. As a result, this research focuses on integrating data collected through fare transactions prior to the survey distribution.

2.4   Summary of Literature Review

Surveys continue to be an important mechanism at public transit agencies to gather customer feedback and better understand travel patterns. However, the large costs in gathering reliable data make this manual data collection efforts infrequent at high levels of detail. With more sources of data becoming available to the transit agency through vehicle location tracking and smart card data, opportunities exist to integrate these sources of information to simplify the manual survey data collection. Online surveys also provide the opportunity to distribute and collect responses more quickly

compared to traditional manual surveys. This chapter provided examples of previous work utilizing automated data to augment and enhance survey responses, as well as give an overview of agency efforts that have begun to look at developing and using online customer panels. As a result of this literature review, this research aims to integrate fare transaction data prior to surveys being distributed to individuals. The following chapters describe the work in implementing an online panel survey for the MBTA and analyze the initial sample of 4,800 passengers participating in the study. The customer panel serves as the mechanism to develop a trip history, integrate the information about prior trips into the survey, and distribute personalized online surveys that replicate traditional manual survey distribution. This method builds on prior research by utilizing panels to improve online surveys, reducing the disadvantages of conducting an online survey over traditional surveys.

Chapter 3

The MBTA Online Panel Recruitment Survey

One purpose of this research is to determine whether the online panel survey approach is an appropriate method for conducting public transit customer satisfaction surveys in public transit and to examine whether the prompted recall approach can improve the customer satisfaction survey responses. To accomplish this task, two phases are used: 1) a sample panel is recruited through an initial screening survey and 2) ongoing follow up surveys are conducted using information obtained through the initial recruitment survey. To accomplish the second phase, contact information needs to be collected such that emails can be sent on an ongoing basis. While emails of some passengers are available through the T-alerts program, a real-time personalized service disruption alert system, these emails are not connected to the smart cards passengers use to access the system (in Boston, the smart card is called a CharlieCard). In addition, no formal agreement exists for individuals to be contacted for survey purposes through that mechanism. Therefore, a separate database of emails is required to conduct the ongoing customer survey phase of the survey. This database of emails linked to CharlieCard numbers is developed using an online survey, available in both English and Spanish. As of March 31, 2014, a total of 4,848 responses were collected using this online survey approach and are analyzed in this chapter. Overall, 3,403 of the serial numbers provided were able to be matched to Automated Fare Collection (AFC) transaction data. This chapter examines how the survey was constructed and distributed at the Massachusetts Bay Transportation Authority (MBTA), the results of the recruitment survey, and the representativeness of the sample collected.

3.1 Recruiting a Sample of MBTA Users for the Online Panel

Promotion and advertising channels were created to recruit the initial online panel, since no mechanism to easily contact a representative sample of MBTA users existed. A link to the online survey was distributed through a variety of channels to gather as many responses as possible and to reduce selection bias of this convenience sample. With only one source of emails to recruit panelists, these methods of advertising the survey were primarily indirect. A summary of the channels in which the survey link was distributed is listed below:

- MBTA.com website: An advertisement was placed on the MBTA.com homepage, where it was one of four prominent rotating advertisements that provide information on service alerts and upcoming projects. This link was placed online in early October, and has been republished periodically since then.

- Twitter: The MBTA's twitter account posted a weekly message asking people to sign up for the survey from October through November 2013.

- Physical advertisements onboard vehicles: Approximately 500 advertisements were printed and placed on buses and subway vehicles to advertise the survey. Tear-off cards with a printed link to the recruitment survey and QR barcodes for phones were attached to the advertisement to allow passengers to have the information and access the survey at a later time. Advertisements were placed on heavy rail vehicles and on buses that serve the high ridership "Key Bus Routes" to maximize the number of people seeing the advertisements.

- T-alerts email and text: The MBTA has a database of passengers who have signed up for T-alerts, a service provided by the MBTA that sends personalized alerts on service interruptions and delays. Individuals who signed up for this service were contacted via a mass email to sign up for the recruitment survey in December 2013 and February 2014, resulting in large spikes in the number of people signing up for the online customer survey.

- Staff outreach: MBTA employees were stationed at select subway stations to hand out advertisements for the initial recruitment survey. These were conducted both during the AM peak and the PM peak periods to increase the number of people reached through this promotion.

A summary of where people reported hearing about the survey through March 21, 2014, is shown in Table 3.1. Overall, the most successful form of promotion was the direct advertisement of the recruitment survey through the T-alerts emails and text messages. Individuals referred from T-alerts signed up quickly after the distribution of the email, but the rate of signups from this email significantly slowed soon after. Passive advertisements on Twitter, the MBTA.com website, and onboard vehicles were also effective at soliciting responses. Responses that cited hearing about the recruitment survey from these sources were not as effective in the number of signups compared to the T-alerts advertising channel, but the rate of individuals joining the panel from these sources were much more consistent over extended periods of time. This is due to the persistence of advertisements on vehicles and the internet compared to the one-time emails distributed through T-alerts. As a result, MBTA staff believe that promotion should take place through multiple forms of media to ensure individuals using the system are exposed to the survey as much as possible.

Table 3.1: Effectiveness of MBTA Recruitment Distribution Methods

Source	Responses	Percentage
T-Alerts email or SMS text	2949	61.9%
MBTA Website	546	11.7%
Onboard Subway	470	9.9%
Onboard Buses	294	6.1%
Twitter @MBTA	216	4.8%
MBTA Staff	147	3.1%
Friends/Family	73	1.6%
The Boston Globe (newspaper)	49	1.0%
Other	135	2.8%

One result of the wide primary promotion of these surveys is the secondary promotion and distribution opportunities provided by social media. Various blogs such as BostInno and UniversalHub as well as the internet-aggregator website Reddit reported on the recruitment survey, resulting in a number of users responding to the survey through these channels. Overall 4,848 responses were collected through March 21, 2014. The survey is still open for enrollment, with signup rates in April 2014 being approximately 10 persons per day. The average enrollment rate in subsequent weeks has dropped to approximately 4 individuals per day, as many of the advertising channels have ceased operation.

Figure 3-1: Location of Serial Numbers on CharlieCards and CharlieTickets

3.2 Design of the Online Recruitment Survey

There were two primary goals of the initial recruitment survey: first, the initial survey creates a panel of MBTA riders who are willing to provide ongoing feedback about the transit service and allow the MBTA to monitor their use of the system; second, the survey collects additional information such as demographics to understand the representativeness of the sample, and to potentially send targeted surveys to specific subsets of the panel. The recruitment survey consisted of 17 questions that should have consistent responses over extended periods of time (several years) and was constructed to be completed within three minutes. This section summarizes the contents of the recruitment survey, and a full version of the survey is available in Appendix A. The survey first asks for the email address of the respondent which allows for future contact with the individual for subsequent surveys. The next piece of information collected is the CharlieCard serial number, a unique numeric string that identifies a card's usage in the system. This connection of email to CharlieCard number allows for analysis of an individual's usage and to potentially tailor future surveys for individuals. Figure 3-1 shows images of the locations of this string value. The following question asks users to express consent to receive future surveys on their travel. This is important for several reasons: it maintains complete transparency of the purpose of the survey, confirms that the respondent wishes to join the customer panel, and gives consent from the user to use CharlieCard transaction data. These three items of information are located at the beginning of the survey as they are the basis for any future surveys conducted through this panel.

Next, questions about the respondent's "typical" usage of the system are asked, in-

cluding questions on frequency of usage, whether the respondent uses multiple Char-lieCards or pays directly with cash, and whether the respondent purchases or receives a monthly pass through the MBTA EmployerPass program. These questions cannot be directly gathered from automatically collected data and likely vary little over time, and thus will be valuable for the agency for several reasons. First, these questions allow for a basic understanding of the prevalence of employer outreach programs and multiple card usage. Second, these questions give the transit agency the opportunity to send future specialized surveys to better understand the effects of these indicators on customer satisfaction and other trip-related customer metrics.

Respondents are then asked about their socio-economic demographics, with questions on age, race, gender, and income. In addition, respondents are asked to provide their home address, with only the ZIP code as a required field to give respondents an option of anonymity. Understanding the geographic distribution of the panel allows for the public transit agency to survey specific cities, towns, or districts and to better target future recruitment efforts. Other questions included in the survey ask about vehicle ownership and possession of a driver's license to determine whether a user is a captive or choice rider on public transit. Finally, the survey asks the respondent where s/he heard about the survey to help determine the most effective marketing tools for future survey recruitment efforts.

One minor modification needed to be added over the course of the recruitment survey to increase the quality of the sample. Due to the formatting of the CharlieCard number stored in the fare payment transaction database, some responses had to be reentered to match survey responses to transactions made in the database. The current format of the serial number takes the form X-YYYY as seen earlier in Figure 3-1, with X indicating the type of fare media (smart card or magnetic stripe) and Y being a numeric string from five to 10 digits in length. The database of fare transactions at the MBTA does not record the leading digit for each transaction. Respondents were only asked to input the digits after the hyphen, with pictures guiding respondents of what string should be input. However, a large number of the respondents still responded with the entire numeric string, including the hyphen separating the two sets of digits. One way to remedy this is to force respondents to input only numeric values, but this was not done to reduce any frustrations from survey respondents who do not realize why their provided response is invalid. Instead, post-processing was done to truncate leading value on entries that had a hyphen or that had a leading digit of 1, 5, or 6 to match with the database of fare payments.

Another minor issue in the response set was having duplicate responses. Duplicate survey responses should be removed as the panel would otherwise weigh the responses of these duplicate entries unfairly. This removal also ensures that an individual is not contacted to complete the survey more than necessary. Seventy-six of the 4,848 responses collected were duplicate entries, either because the individual forgot that s/he completed the survey or because the respondent clicked the submit button multiple times. Responses were checked to see whether a survey response differed from one entry to another. If one entry contained more information, that record was kept; otherwise the more recent entry was kept. Duplicate entries are not included in the subsequent results of this chapter.

3.3   Effectiveness of the Online Recruitment Survey

Perhaps the most important objective of this initial survey is to recruit respondents who are willing to be contacted in the future and to determine whether enough information is provided to simplify future surveys. People who do not agree to be contacted in the future will not provide ongoing information regarding their satisfaction with MBTA services and thus should be excluded from future analysis. In addition, providing a valid CharlieCard number is critical for future surveys as the trip histories are referenced to understand the survey respondent's travel patterns. This also serves as the method of determining a previous trip segment to display when subsequent surveys are distributed using the prompted recall method. Table 3.2 summarizes the recruitment survey responses by whether they agreed to be contacted in the future, whether they provided a valid CharlieCard number, and whether this number matches any fare transactions in the AFC database between October 2012 and March 2014.

Nearly all of the people who completed the initial recruitment screening indicated that they were willing to participate in subsequent surveys. This is an encouraging sign, as these respondents would like to provide critical feedback to improve service and were not discouraged by any of the more intrusive demographic questions. The second subset consists of individuals who provided a valid CharlieCard number to be used to track their system usage and to obtain more details about past trip history in follow-up surveys. Eighty-five percent of the respondents who opted in for future

Table 3.2: Completeness of Survey Results

	Number	Percentage
Total responses	4772	100%
Opted in for future surveys	4350	91.5%
and		
Provided a non-zero CharlieCard value	3719	77.9%
and		
Matched CharlieCard to fare transaction records	3403	71.3%

surveys, or 78 percent of all surveys completed, provided a reasonable CharlieCard number (non-zero or non-single digit). Some people entered no value, either due to privacy concerns or because they did not have a CharlieCard in their possession at the time. The last subset consisted of individuals who had provided a CharlieCard serial number that matched a recent fare transaction recorded in the AFC database. Of the people who opted in and provided valid CharlieCard numbers, 92% of the cards were matched to a recent fare transaction, which provides a large number of respondents with complete information and willingness to participate in subsequent follow-up surveys.

3.4 Representativeness of Panel Recruitment

Survey responses should be representative of all individuals in the system. Because this recruitment of the panel was constructed with a convenience sample and conducted online, there are several biases that can occur. First, only people who signed up for the survey and were willing to be contacted are included in this sample. Individuals who did not sign up for the survey may have different characteristics from those who did. As the survey is conducted online, differences between the panel and general ridership may occur from individuals not being technologically savvy or having access to email or the internet. This section analyzes the representativeness of the survey on several metrics: demographics, geography, and usage of the system. As the recruitment was conducted through a convenience sample, analysis should be done to ensure that the panel is representative of the population riding the MBTA and/or the population of the Greater Boston region. Over half of the questions in the recruitment survey were asked to check the representativeness of the sample, and allow for specific subgroups to have surveys distributed in the future. This analysis helps ensure that

all customer groups are properly represented and allows for the MBTA administration to target specific demographic groups or locations with additional panel recruitment outreach efforts to reflect the customer population characteristics.

3.4.1 Demographic Comparison

The demographics of the recruitment survey panel were compared to two sources: the most recent ridership study conducted in 2008–2009 by the Central Transportation Planning Staff (CTPS) and to the 2010 American Community Survey (ACS) for the Boston MPO region. This comparison looked specifically at age, race, gender, vehicle ownership, and income. Note that only the respondents who have agreed to receive future surveys are included in this section, as the respondents who did not opt-in will not become part of the ongoing survey panel.

Age

As shown in Table 3.3, the recruitment survey tended to have a larger proportion of people aged 45-64 compared to both the CTPS survey and the ACS. In this case, the CTPS survey results provide a better baseline comparison for the recruitment survey as there is a large general population of children under the age of 18 who likely would not ride the bus alone. However, even comparisons to the ridership survey show a large proportion of college-aged students and senior citizens who are under-represented in the panel. Outreach can be made in college campuses and senior centers to improve the number of responses in these age groups. This outreach needs to be an ongoing process, as college students are highly mobile after graduation and may have a higher likelihood to drop out of future panel surveys. Overall, though, the recruited panel seems to be broadly representative of MBTA customers with respect to age.

Race and Ethnicity

The recruitment survey asked respondents to report which race s/he belongs. As seen in Table 3.4, the recruitment panel has is overrepresented by individuals self-identifying as white. Only 7.6 percent of respondents identified themselves as Black or African American, which compares similarly to the ACS but is underrepresented by 9 percent compared to the CTPS ridership study. The recruitment survey also asked if individuals are of Hispanic origin. Table 3.5 shows that, at 4.1 percent of the panel, the percentage of Hispanic individuals is much lower than the proportion

Table 3.3: Comparison of Age in Surveys

Age	Survey (Opt-in)	CTPS	ACS
18 or younger	1.1%	2.6%	20.7%
19-24	8.5%	14.1%	10.9%
25-34	27.5%	27.1%	14.7%
35-44	19.7%	17.6%	13.7%
45-64	38.8%	31.5%	26.6%
65 or older	4.3%	7.1%	13.4%
Total	100%	100%	100%

of riders, as calculated by the CTPS. This could be attributed to the survey being primarily advertised in English. To increase the proportion of Hispanic respondents, the survey was translated into Spanish and placed as an option at the same link as the English survey. However, only 18 responses were recorded in the Spanish version of the survey some two months after its introduction. More outreach should be done to increase the proportion of minorities in the panel, including advertisements in Spanish to encourage passengers to sign up for the survey.

Table 3.4: Comparison of Race in Surveys

Race	Survey	CTPS	ACS
American Indian	0.9%	1.6%	0.2%
Asian	4.3%	8.9%	8.6%
African American/Black	7.6%	16.6%	8.6%
Hawaiian/Pacific Islander	0.4%	0.3%	0.0%
White	83.5%	68.3%	76.3%
Other	3.0%	7.2%	7.2%

Table 3.5: Comparison of Individuals with a Hispanic Background in Surveys

Hispanic	Survey	CTPS	ACS
Yes	4.1%	8.90%	17.5%
No	95.9%	91.1%	82.5%
No Answer	3.7%	6.7%	—

Gender

Table 3.6 shows the proportion of each gender in the recruitment survey, the CTPS ridership survey, and the ACS. Fifty-four percent of respondents were female, which

is consistent both with the CTPS system-wide study and the ACS proportion of females in the Boston population. No recommendation is made to try to increase the proportion of either gender as results generally meet the current expectations.

Table 3.6: Comparison of Gender in Surveys

Gender	Survey	CTPS	ACS
Male	44.4%	39.0%	48.2%
Female	54.2%	60.9%	51.8%
Other/Prefer not to say	1.4%	0.1%	—

Household Vehicle Ownership

The number of vehicles owned by a household plays a role in determining the likelihood of using public transit. Captive riders, or those with no access to a vehicle, are more likely to use public transit compared to choice riders, or those with access to a vehicle. A related question asked whether the respondent possesses a driver's license to better determine whether a passenger might be captive to public transit. Results comparing the ownership of vehicles in both the recruitment survey panel and the Boston MPO region is shown in Table 3.7.

Twenty-one percent of respondents reported not having a vehicle in the household. This is higher than the regional estimate of non-vehicle ownership at 16 percent. In addition, fourteen percent of the recruitment survey panel did not possess a driver's license. The results here conform to expectations as there should be a higher proportion of households without a car who use public transit compared to the general population.

Table 3.7: Comparison of Vehicle Ownership and Driver's License Possession in Surveys

Vehicles in Household	Panel Total	Boston MPO Region	Respondent has Driver's License	
			Yes	No
0	20.9%	15.8%	14.3%	6.6%
1	35.8%	36.9%	31.3%	4.5%
2	31.8%	34.7%	29.8%	1.9%
3 or more	11.5%	13.6%	10.9%	0.6%
Total	100%	100%	86.3%	13.7%

Income

Income as a question on the recruitment survey was added at the request of MBTA and CTPS staff who wanted to better understand the proportion of people that were in low income households. For the Boston region, the threshold for a low income household is currently a median household income of below $41,636. Responses in Table 3.8 only reflect those individuals who completed the survey after the income question was added. While the other surveys had used different ranges for the question about income, these are proportionally assigned to each correct proportion and tabulated in the same table to allow for a comparison to be drawn.

Table 3.8: Comparison of Income in Surveys

Income	Survey	CTPS	ACS
Under $20,000	7.9%	13.6%	15.3%
$20,000 − $41,999	12.2%	16.9%	15.7%
$42,000 − $65,000	17.2%	19.1%	15.3%
$65,000 − $99,999	22.9%	22.3%	19.2%
Over $100,000	39.7%	28.1%	34.5%

Approximately 20 percent of the panel were below the low-income threshold set by the region. This proportion of low income households is significantly lower than both the proportion of riders completing a survey in the CTPS ridership survey and the Boston MPO region, where approximately 30 percent of individuals in both groups are defined under this category. This could be attributed to the format of the recruitment survey, as lower income individuals would be less likely to have smartphones and access to the internet. Some self-reporting bias may also occur here, as individuals will be less likely to report their income on this survey compared to the ACS. Only 90 percent of individuals who completed the survey responded to this question, a lower response rate compared to other demographic questions in the recruitment survey. The high proportion of individuals with household incomes greater than $100,000, as will be seen in Section 3.4.3, is likely attributed to the high proportion of commuter rail users in the panel. Suburban communities typically have higher incomes than urban communities, and an overrepresentation of these individuals in the panel would skew the proportion of these individuals in the panel. As a result, more outreach should be conducted in areas with high proportions of low income residents to make the panel more representative.

3.4.2 Geographic Home Location Comparison

Home location is also an important factor when analyzing the representativeness of the panel. Having a diversity of responses by geography ensures that each population that the MBTA serves is represented when surveys are conducted. The responses were aggregated by ZIP code and input into geographic information system (GIS) software to visualize the location of the responses. The ZIP code was selected as the method of aggregating responses as respondents are most likely to know their ZIP code and provide this information. In addition, this aggregation provides some comparison with other data available in the visualization of the distribution of responses. A map of the Boston area showing the number of responses by ZIP code is shown in Figure 3-1, while Figure 3-2 shows the number of responses normalized by the population from the 2010 Census.

A large number of responses were received in South Boston, Jamaica Plain, Brighton, and Malden, with decent rates of recruitment in the rest of Boston and the surrounding cities. A smaller proportion of responses were received in the suburban neighborhoods served by commuter rail, but these recruitments in total were still significant, constituting approximately 42 percent of the panel. Few responses were recorded in Downtown Boston and the Back Bay region, but when comparing ZIP codes by responses as a proportion of the population, it becomes clear that the areas with low numbers of responses also had lower populations, as much of the Downtown and Bay Bay area is occupied by commercial developments. Nevertheless, the Back Bay neighborhood still has a lower percentage of the population signed up for the survey, but the urban region as a whole has a more uniform rate of individuals signing up for the panel. The relatively low response in Chelsea, Everett, and East Boston can possibly be attributed to the high Hispanic populations, which were underrepresented as discussed in Section 3.4.1. Responses were recorded in all ZIP codes that are served by MBTA buses and subway lines, which shows the ability of the online recruitment to be widely distributed among the population. Displaying the geographic distribution of panelists highlights areas that can be targeted to increase survey recruitment efforts to maintain a more even distribution of respondents across the region.
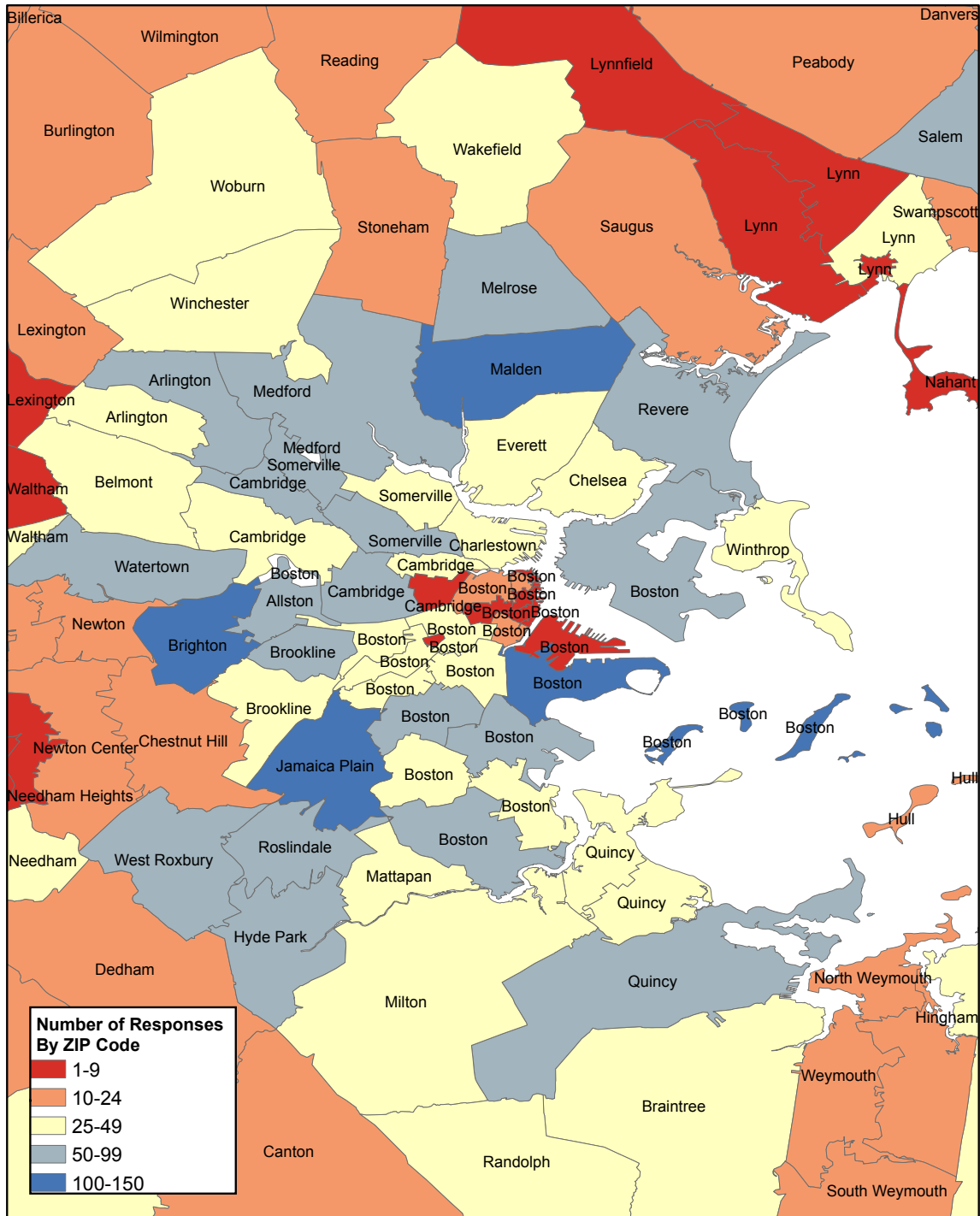
Figure 3-2: Distribution of Recruitment Survey Responses by ZIP Code
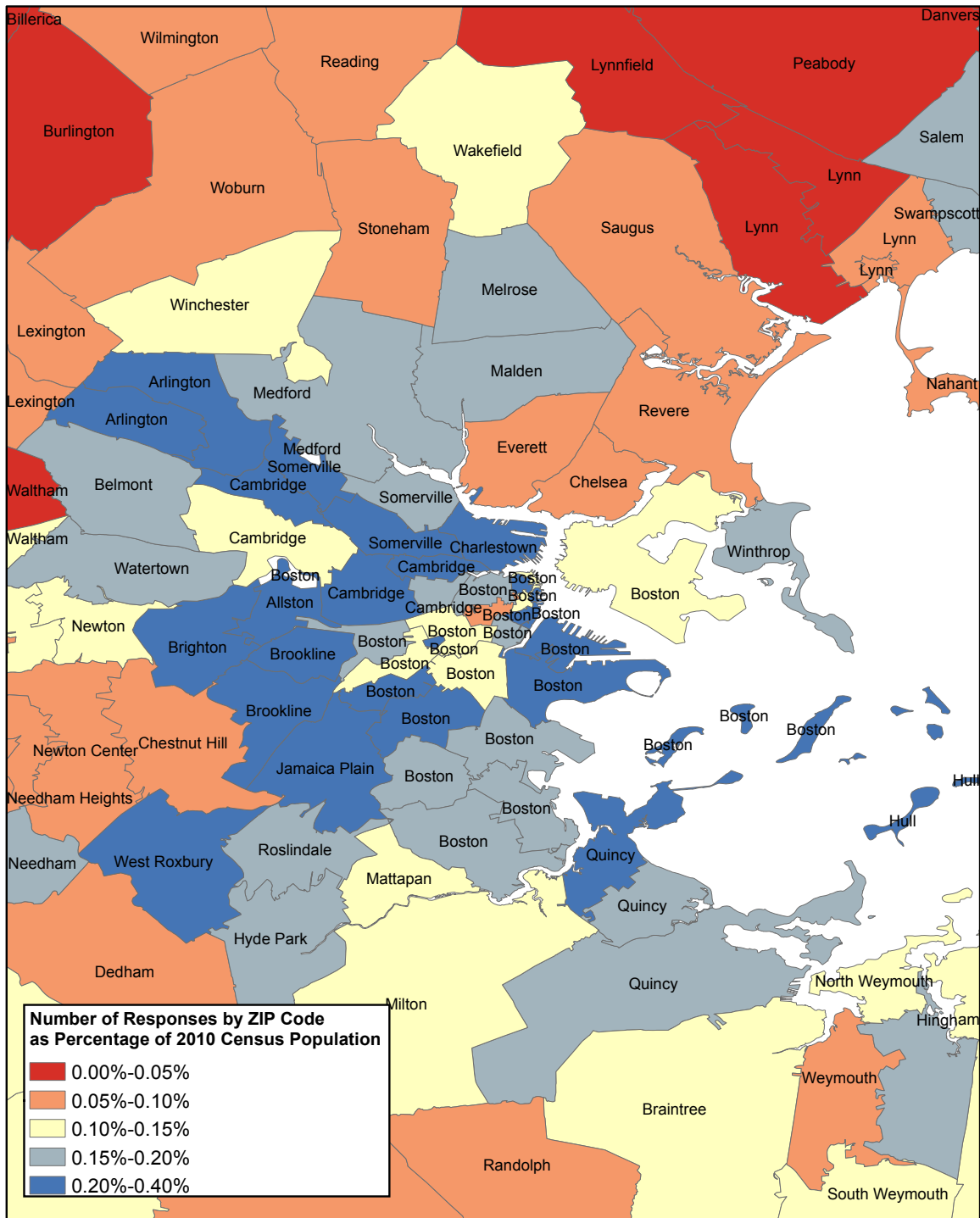
Figure 3-3: Distribution of Survey Response as a Percentage of the 2010 U.S. Census Population

3.4.3 Ridership Fare Type Comparison

Another comparison can be made to analyze whether the customer satisfaction panel is representative with respect to the types of fare payments used in the system. This is especially important when gathering feedback about changes to fare policy, as different groups of individuals may be affected disproportionately. Due to the ongoing nature of this survey, regular riders would be much more likely to join the panel group compared to riders who make limited trips or are visiting the area. The frequent usage of the system results in more opportunities to see the advertisements throughout the system and sign up for the survey. In addition, travelers who may use the system frequently over a short period of time would likely not be included in this survey panel, as they would be unlikely to have repeated measurements. To that end, the distribution of fare payment types was compared for survey recruitment panel and all fare transactions recorded in 2013. The survey panel was compared against trip records rather than individual cards, as there exists a disparity in the length of usage by each fare type. For example, a four one-week passes will be used in the same time frame as one monthly pass. Multiple single-trip tickets used by one individual would also skew the results, resulting in a non-comparable sample. To ensure that these values are somewhat representative, the average number of trips on a card per active day is calculated, with the results shown below in Table 3.9.

Table 3.9: Average Number of Unlinked Trips per Active Day by Fare Payment Method

Fare Payment Method	Average
1 Day Pass	2.91
7 Day Pass	2.59
Monthly Adult	2.50
Monthly Senior/Student/T.A.P.	3.28
Stored Value Adult	1.80
Stored Value Senior/Student/T.A.P.	1.52

The number of transactions per day is fairly consistent between 2.5 and 3 for different types of unlimited use passes, while stored value transactions have fewer transactions at 1.5 to 1.8 trips per day. While the number of average number of daily trips used on a stored value card is much less than, the average number of unlinked trips among non-stored value users remains fairly consistent, which provides a better basis. With this in mind, the percentage of individuals purchasing each fare type is compared to the number of fare transactions is shown in Table 3.10.

Table 3.10: Comparison of Fare Payment Methods in Customer Panel

Fare Payment Method	Customer Panel	Fare Transactions 2013
Monthly Pass Adult	42%	29.6%
Monthly Senior/T.A.P./Student	3%	5.7%
Stored Value Adult	30%	44.4%
Stored Value Senior/T.A.P/Student	4%	4.6%
7 day pass	3%	9.8%
1 Day Pass	0%	0.2%
Commuter Rail	18%	4.2%
Other	0%	1.4%

The main result from this comparison is the oversampling of monthly pass holders and commuter rail users compared to the more general sample of fare transactions. While some of this is attributable to the demographics of the respondents, this also is in line with expectations, as users likely to participate in the sample are likely to be frequent users and likely to hold passes that allow for more usage compared to the occasional user. Stored Value and shorter term passes are under-represented in the sample.

3.5 Recruitment Survey Results Regarding System Usage

The recruitment survey also allowed for information to be gathered about system usage that would not be attainable through the automatically collected data. This information can help refine the survey distribution by focusing on specific types of individuals to survey. Questions on reported usage, the availability of employer provided passes, and the availability of multiple fare payment instruments were included in this initial survey to better understand the individuals in the panel. These pieces of information, like the rest of the recruitment survey questions, are not likely to change frequently, and therefore were included in the recruitment survey rather than subsequent follow-up surveys.

3.5.1 Comparison of Reported Usage to Actual Usage

One comparison examined here is between a respondent's reported usage of the system from the survey and his or her actual usage of the system based on their CharlieCard fare transactions. Using the CharlieCard number provided by each respondent in the recruitment survey, the ride history of the respondents was referenced over the time period November 2013 to March 2014 to analyze the frequency of use in the system. The month with the most days with active use on the card made by an individual was selected for analysis, and the number of active days scaled to the one-week level to have a standard method for comparison. For respondents with one week passes, the number of active days in the month was equivalent to a week; for other respondents with monthly passes and stored-value CharlieCards, the number of active days was divided by the number of days in the month and multiplied by 7 to get average usage at a weekly level. Table 3.11 compares the reported usage of the system with the usage recorded on the provided CharlieCard number.

Table 3.11: Comparison of Survey Reported Usage and Recorded Usage on User-provided CharlieCards

	Recorded Usage			
	Less than 1 day a week	1-2 days a week	3-4 days a week	5 or more days a week
Less than 1 day a week	1.4%	1.1%	0.2%	0.0%
1-2 days a week	0.6%	3.3%	0.9%	0.3%
3-4 days a week	1.2%	3.9%	6.0%	2.1%
5 or more days a week	8.3%	7.9%	17.7%	45.2%

The shaded diagonal shows those respondents whose reported frequency of use matched the frequency of use on the provided CharlieCard. Approximately 5 percent of respondents under-reported their trip making (above the shaded diagonal), while approximately 40 percent of respondents over-reported the trips made on the MBTA (under the shaded diagonal). There are several possible explanations for this result: 1) respondents perceive that more trips are being made than are actually made or 2) passengers might pay for trips either using cash or another CharlieCard. While the actual reason for this systematic under-reporting cannot be directly determined directly through the recruitment survey, subsequent surveys do ask if another CharlieCard was used by the respondent and begin to ask about trip histories, allowing

for more comparisons to be made between reported usage and recorded usage. These biases confirm the need to have some integration between AFC transaction data and survey data when conducting surveys. The confirmation of prior usage should allow for more accurate depictions of usage by an individual, and therefore improve the accuracy of the overall survey.

3.5.2 Payment Types

Passengers using the MBTA have multiple ways to pay MBTA fares, including cash, magnetic stripe cards (CharlieTickets), smart cards (CharlieCard), and payments through smartphone applications. To better understand how people pay when using the MBTA, a question was including asking respondents how fares were paid: with only one CharlieCard or CharlieTicket, with cash and a CharlieCard or CharlieTicket, or with multiple CharlieCards or CharlieTickets. As there is currently no way to associate multiple cards with a single person, trips made on different cards are assumed to be associated with different people. However, in reality people might pay with cash instead of using the CharlieCard or use multiple smart cards over time. Therefore this question aims to understand the prevalence of using multiple forms of payment on the MBTA. Table 3.12 shows the results of this question.

Table 3.12: Distribution of Payment Methods in Customer Panel

	Respondents	Percent
Only 1 CharlieCard	3312	69.7%
Multiple CharlieCards	832	17.5%
Cash and CharlieCards	626	12.2%
Total	4752	100%

Overall, seventy percent of respondents reported only using one CharlieCard to pay for fares in the system. Over 17 percent reported paying for the MBTA using multiple CharlieCards and 12 percent using cash in addition to the CharlieCard. For these two groups, we can expect to find a systematic over-reporting of the total trips taken, as some trips reported by the user would not be associated with the original CharlieCard number provided in the survey. This provides some explanation into why some trips are over-reported in section 3.4.1, but even after selecting respondents only using one CharlieCard to pay the MBTA fare, 37 percent of respondents still over-report their usage on the MBTA system.

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The result of this question also shows that 17.5 percent of individuals will likely have multiple records in the system, which shows the importance of linking all CharlieCards an individual owns to a specific account. The beginnings of associating multiple CharlieCards with an individual can be constructed using the customer satisfaction survey, where individuals are asked if a new CharlieCard is used to complete the trip. However, knowing that 30 percent of individuals may have unreported trips on the CharlieCard provided in this survey reduces the likelihood that an individual will have a trip recorded on the CharlieCard provided to include in a subsequent survey, reducing the utility of the prompted recall approach for the survey. Follow-up surveys should continue to ask which card was used to complete a previously completed journey to continue the agency's ability to analyze past trip behavior.

3.5.3 Employer Passes

One of the established methods of encouraging public transit use in the Boston region is through employer provided unlimited use monthly passes. In Boston, the Corporate Pass Program has allowed the MBTA to maintain a stable source of revenue by coordinating with employers to provide their employees with "subscription," or automatically renewing, monthly transit passes. In almost all cases, the transportation benefit is provided to employees on a "pre-tax," or tax-free basis, saving these employees a significant sum annually compared to those who purchase retail monthly passes with "after-tax" money. This provides a discount of 25–33 percent for most individuals. With the significant savings provided through this program, one question was included to understand what proportion of respondents use this method to purchase fares on the MBTA system, and whether some employers provide some additional or alternate subsidy for commuting to and from work. Results from this question are shown in Table 3.13.

Table 3.13: Distribution of Enrollment in Employer-provided Subsidies in Customer Panel

	Respondents	Percent
No Employer Pass	2440	51.4%
Employer Debit	583	12.3%
Corporate Pass Program	1729	36.4%

A large majority of people in the panel survey use some form of employer benefit, with 49 percent of respondents receiving some sort of subsidy by an employer for travel on

public transit. Thirty-six percent of respondents participate in the Corporate Pass program, which constitutes a significant proportion of respondents. Knowing that an individual purchases a transit pass through the Corporate Pass program is important as the usage of the system may not be identical to that of a "regular" or retail MBTA pass purchaser. As shown by Kamfonik (2013), individuals in the Corporate Pass program used the public transit system 17 percent less compared to usage by a retail pass user. This also may influence how users perceive changes in fare policy, as these users are typically subsidized to use public transit. With the significant differences in usage patterns for individuals with employer-provided passes, future studies can look at differences in behavior among the three different groups to see whether the Corporate Pass program changes the perception of using public transit.

3.6   Conclusions and Recommendations

The method of collecting emails and transit smart card numbers prior to subsequent surveys is critical for future longitudinal surveys, especially if the public transit agency desires subsequent ongoing surveys where select trip information is provided in the customer satisfaction survey. While the number of signups is less than 1% of the total unlinked trips in the MBTA system, the current number of 4,350 people willing to provide feedback on an ongoing basis is still a successful result. In addition, 71.3 percent of individuals who completed the survey have provided a transit fare card number matching records in the AFC database. The success of the signup was primarily due to the large number of people who responded through the active mass email advertising of the survey through T-alerts. In the future, the signup page for the T-alerts program should link to the recruitment survey to increase the panel sample, as these individuals show an increased interest in the public transport system and may sign up in greater rates than the general population. However, passive advertising still remains important to ensure that as many people as possible have the chance to sign up for the survey and give feedback to public transit agencies. With most of the advertisements on websites and the buses lasting only for several weeks, the recruitment rate for the panel has severely diminished. Ongoing public outreach for the customer panel is needed to offset the attrition of people who do not wish to remain in the panel, move out of the region, or buy a car. Therefore, the other forms of advertisement on the MBTA website and on bus and subway vehicles need to be conducted on an regular basis to continue building the customer panel. As subsequent

surveys are distributed to the panel, word of mouth may help spread the panel to more people who want to provide feedback to the transit agency.

While there are some differences between the demographic make-up of the survey panel and the more general ridership of the MBTA, these differences do not pose significant risks to greatly skewing future survey responses. If the proportion of individuals by a specific category becomes a concern in terms of certain groups being underrepresented, responses can be weighted in future surveys to ensure that the result is representative of the overall population. The differences between the recruitment survey and the general population in terms of geographic distribution and race can be remedied through more direct advertising in specific areas to encourage more people to sign up and provide feedback to the transit agency. By acting on the available information and encouraging more people to sign up to correct the existing proportion of respondents to better reflect actual ridership, future surveys regarding customer satisfaction and other pertinent topics to transit agencies will not likely need to be weighed to correct for differences in customer demographics.

Lastly, the results from the recruitment survey also give some insight into the panel and serve to guide future surveys. The knowledge that over one in six respondents pay transit fares using multiple CharlieCards reiterates the need to ask for this information in each survey. This becomes especially important given the large proportion of commuter rail users, who will have different fare payment tickets each month. Without this constant verification of fare payment methods, the value in analyzing past trip behavior will diminish, as existing cards would no longer have any active transactions being recorded. The knowledge of the prevalence of employer provided subsidies, either through the MBTA Corporate Pass program or through other programs, also alters how users may be analyzed. Previous research has shown the difference in system usage given this employer subsidy. Satisfaction of the public transit system and reactions to changes in fare policy may also be affected by the availability of these employer subsidies. The knowledge provided through asking these questions in initial recruitment survey allow for the ability to further refine the distribution of these surveys to better analyze passenger satisfaction with public transit agencies.

Chapter 4

The MBTA Customer Satisfaction Survey

One use of the online panel of Massachusetts Bay Transportation Authority (MBTA) customers is gathering regular feedback for the transit agency. Through periodic online surveying, public transit agencies are able to measure changes in customer satisfaction given changes in service levels, fares, and/or service quality. The panel can also be used to solicit input on fare policy and other general questions on which the agency may want feedback. This chapter will focus on the first two months of customer satisfaction surveys conducted online in February and March 2014. These customer satisfaction surveys asked panelists to describe and rate a recent journey made on the MBTA system.

The survey was distributed in two versions: a general version that asks if the user used the MBTA and asks questions about the most recent journey made, and a prompted recall version that uses the respondent's Automated Fare Collection (AFC) database trip history linked from the user provided CharlieCard number to ask about a specific previous journey. Overall, 2,000 survey invitations were distributed by email to the previously recruited online panel, with 1,320 complete responses collected. This chapter discusses the distribution and design of the customer satisfaction survey, the response rate, as well as specific results such as the perceptions of the service provided.

4.1 Distribution of the Customer Satisfaction Survey

The MBTA survey panel's usage of the MBTA was analyzed each month to determine who would be invited to participate in the periodic customer satisfaction survey. Respondents were analyzed by linking the CharlieCard serial number provided in the recruitment survey to records in the fare transaction database to determine whether a trip was made on the card in the week prior to survey distribution. The panel was divided into two groups based on this criterion – one with a trip made in the week prior and a second without any recorded MBTA usage. Individuals were randomly selected from both groups to be invited to complete a survey, with the group that had trip records within the past week further subdivided into two groups, one that receives the general survey and one that receives the prompted recall survey. Since the analysis to place a panel member in a group is conducted every month, a panelist may be in a group that is asked about a specific journey with information provided (prompted recall survey) for one survey and a different group with no information (general survey) in a subsequent survey. Surveys are also distributed such that approximately an equal number of surveys will be collected each month, and that any one individual will not be asked to complete a survey more than four times a year. The main reason for surveys to be distributed 4 times a year is the idea of having a quarterly report, as some transit agencies with customer panel surveys such as NJ Transit report customer satisfaction on a quarterly basis. However, it remains to be seen if this survey frequency is too much for some individuals. This can be determined by the percentage of individuals opting out of following surveys given the time between survey solicitations to the individual. To complete this customer satisfaction survey, individuals are given a personalized link which expires after survey completion to ensure that only one response is received from each individual. Users are also given the opportunity to opt out of future surveys in this survey invitation. A copy of the invitation email sent to survey participants is shown in Figure 4-1.

Before distribution to the a larger group of the recruited panel, a small pilot was conducted in early February with 25 members of each group to get a basic estimate of response rates and to resolve any possible issues with the automated distribution mechanism. Based on the pilot, estimates were made that 40 percent of individuals with no prior trip record would respond to the follow-up survey, while 60 percent of individuals with a trip record would respond. With this information, the number of

Take the MBTA panel survey and win a free LinkPass
MBTA Customer Research [noreply@qemailserver.com]

To: [Email]

Dear MBTA rider,

We would like to know about a recent experience you had riding the MBTA. You signed up as part of the MBTA Customer Survey Panel on [recruitment survey date]. When you signed up, you agreed to let the MBTA contact you regarding your usage of the transit system. This survey will ask you to complete a series of questions about a previous trip made on the MBTA.

Each completed survey is entered for a chance to win a free monthly LinkPass.

Follow this link to the Survey:
Complete the survey here

Or copy and paste the URL below into your internet browser:
https://mitresearch.qualtrics.com/SE/?SID=SV_a5e2OIRsJMYQJ0h&Preview=Survey&_=1

Thank you for your continued participation,

MBTA Customer Research

Massachusetts Bay Transportation Authority

Follow the link to opt out of future emails:
Click here to unsubscribe

Figure 4-1: Email Invitation Sent to Panel Members to Complete Survey

people selected for the February survey from each group was determined such that approximately 150 general surveys with no trip record in the previous week and 100 prompted recall and general responses each with trip records would be completed and returned. The number of invitations to complete the March surveys was the same for all three groups, as the full survey in February provided an almost equal response rate for each of the three sample groups. A summary of the number of survey invitations distributed each month by sample group along with the response rate is shown in Table 4.1.

Table 4.1: Number of Surveys Distributed Each Month by Type

	General - Unlinked		General - Linked		Prompted Recall		Total
Pilot	25	40.0%	25	64.0%	25	64.0%	75
February	375	61.8%	175	72.5%	175	69.1%	725
March	400	60.0%	400	68.8%	400	70.8%	1200
Total	800	60.3%	600	69.7%	600	70.0%	2000

Two-thousand unduplicated survey invitations were distributed via email, constituting 45 percent of the recruited panel who were willing to participate in future surveys. A reminder email was distributed one week after the original distribution of survey links to ensure that participants were reminded of the survey at least once. For individuals participating in the prompted recall group, trip records were analyzed again to ensure that a trip was made in the week prior to the reminder email. If no trip was recorded for that individual, then no reminder email was sent.

4.2 Design of the Customer Satisfaction Survey

The purpose of this survey is to understand how MBTA passengers perceive the service provided on a recently made journey as well as the agency in general. As with the recruitment survey, this survey was conducted online, and is split into several pages to ensure individuals are not discouraged seeing a long series of questions. The survey was estimated to be completed in less than 15 minutes. A full copy of the customer satisfaction survey is in Appendix B.

The customer satisfaction survey begins by asking whether a journey was made on the MBTA by the individual in the past week and to rate the MBTA on the following

scale:

- 1 – Extremely Dissatisfied
- 2 – Very Dissatisfied
- 3 – Somewhat Dissatisfied
- 4 – Neutral
- 5 – Somewhat Satisfied
- 6 – Very Satisfied
- 7 – Extremely Satisfied

For individuals who did not make a journey in the past week, the survey terminates, as the remainder of the survey would not pertain to the respondent. While these are valid responses to the survey, they are not considered in the remainder of the chapter, as the customer satisfaction survey focuses on indivudals who completed a recent journey on the MBTA.

The following section asks the respondent to describe the journey made on the MBTA. First, the user is asked to input the date and approximate time the journey was begun. The date and time was entered using a dropdown box with time segments in 15 minute increments to reduce any errors with entering the time in a 12 hour or 24 hour format. Questions about the origin and destination of the journey are asked, including the address, type of location such as home or work that the individual is traveling to and from, and how the individual accessed the MBTA. Other questions about the journey include frequency of said journey and whether alternatives such as bicycling, driving, or carpooling were available for this journey.

After general trip information was collected, the respondent is asked to detail the specific order of routes used on the MBTA. The user records each trip segment made on the MBTA through a nested drop down menu by first selecting the type of transit (Bus, Subway, Commuter Rail, Ferry), followed by the specific line used. If the passenger used a form of rail transport, then s/he is also asked to provide the station at which the respondent entered the system. This section also asks how long the respondent spent accessing the MBTA system, the time spent waiting for each vehicle used, and the time spent traveling on each vehicle. Up to four trip segments were provided for user input. If the user indicates that fewer than four vehicles were used to complete the journey, then the survey skips those questions. A final question on the specific journey asks the station the passenger used to exit the system if the last segment of the journey was made on a rail line. Stop level detail was not

provided for bus routes for two reasons: first, users are not likely to know or remember the specific name of the bus stop; second, the MBTA system includes thousands of bus stops that could not be easily displayed through dropdown boxes in a survey. Future implementations could remedy this issue by having the respondent pinpoint the general boarding location on a map and geocoding the information to find the nearest bus stop. In addition, the survey asks what kinds of information were used, if any, while making the journey, such as real-time vehicle arrival information, station maps, or published schedules.

The survey also asks whether the user has switched CharlieCards since the last time the user was surveyed. If so, the user is asked to provide the new CharlieCard number which provides an ongoing ability to understand individual trip history over a longer time period using several CharlieCards. This is especially important in the case of commuter rail monthly passes, which are still distributed as magnetic strip passes each month. These numbers are reused each year as well, so a commuter rail pass one year is likely to be associated with a different individual each year. Therefore, it becomes especially important to associate commuter rail passes with the correct individual to ensure accurate fare transaction reporting. Lastly, the respondent is asked to rate certain characteristics of the journey, such as waiting time, stop condition, vehicle cleanliness, and seat availability as well as the overall journey.

The final section of the survey asks users how satisfied they are with certain aspects of the MBTA system such as the website and announcements of delays, followed by a series of attitudinal statements to understand how MBTA passengers perceive the service the agency provides and how the agency is run. The statements in this section include, but are not limited to, the following:

- The MBTA provides reliable public transportation services.
- The MBTA uses technology to meet the needs and demands of its riders.
- The MBTA is a cost conscious organization.
- I use the MBTA because I consider myself to be an environmentally conscious person.

This section also asks about the likelihood to recommend the service to others and continue using the system. Finally,the respondent is asked again to generally rate the agency and provide any other comments for the transit agency, after all other survey information is collected. The survey concludes with a question asking users if they would like to be included in the lottery drawing for a monthly Linkpass, the incentive

offered to complete the survey.

Both surveys were first piloted internally to determine whether any questions needed to be reworded or if instructions were unclear in any way. Several questions were altered to include "Not Applicable" as a possible response for items that did not pertain to the respondent. Wording was changed for some questions to improve clarity, and the questions asking respondents to input subsequent trip segments include the previous segments entered to increase clarity of the complete journey that is entered.

4.3 Response and Opt-Out Rates of the Customer Satisfaction Survey

Understanding the ongoing response rate is important for this panel survey as it relies on a previous survey to collect responses. On one hand, one might expect fewer people to respond to a periodic repetitive survey when compared to conducting a single survey due to people moving out of the region or simply not being interested after the initial survey. On the other hand, the response rate of this customer satisfaction survey is hypothesized to be fairly high since the initial panel of individuals surveyed had voluntarily agreed to complete future surveys for the MBTA. This section analyzes the number of responses collected as well as the rate at which they responded. As an incentive to individuals to respond to the survey, three monthly LinkPasses were offered as a lottery prize to respondents for each monthly survey.

The online commercial survey software used here, Qualtrics, allows for the distributor of surveys to determine how many of the surveys were started but not completed (Qualtrics, 2014). It also notes the number of surveys that were not received by the intended recipient and the number of individuals who decide to be removed from future surveys. Out of 2,000 surveys distributed to individuals, seven individuals opted out of subsequent surveys from the MBTA while fifteen emails did not reach the intended recipient, resulting in a successful distribution rate of 99 percent. Seventy-five percent of the individual survey links were opened and approximately 88 percent of those who opened the survey completed it and provided a complete journey. Table 4.2 and Table 4.3 show the percentage of surveys that were opened and completed by month and by survey group. People who had a trip record in the past week had significantly higher rates of the survey being opened and completed. However, there

was no significant difference in the response rate between the two groups that had individuals with AFC transactions in the week prior to the survey distribution. Survey completion rates were consistent both across groups and over the two months of reporting, which suggests that providing additional information in the survey does not change the likelihood for an individual to complete the survey. Overall, knowledge of MBTA usage prior to distributing surveys does increase the likelihood that an individual will complete the survey.

Table 4.2: Number and Percentage of Surveys Opened by Type and Month

	General - Unlinked		General - Linked		Prompted Recall		Total
February	303	75.8%	156	78.0%	162	81.0%	77.6%
March	278	69.5%	291	72.8%	305	76.3%	72.8%
Total	581	72.6%	447	74.5%	467	77.8%	74.8%

Table 4.3: Number and Percentage of Surveys Completed by Type and Month

	General - Unlinked		General - Linked		Prom. Recall		Total
February	242	60.5%	143	71.5%	137	68.5%	68.0%
March	240	60.0%	275	68.8%	283	70.8%	67.8%
Total	482	60.3%	418	69.7%	420	70.0%	67.9%

Another way to look at the response rate is to look at the time from when the survey was distributed to the time the survey was completed. Figure 4-2 shows the distribution of the percentage of responses completed after the emails were sent, with time on the x-axis on a logarithmic scale to increase clarity in visualization of the response rate. One-third of the responses were submitted within one hour of the distribution of the individual survey links, with two-thirds of the responses completed on the same day the email was sent. Previous studies comparing email surveys to mail surveys have shown that emailed surveys were returned more quickly, with one study showing that 54 percent of email responses being returned within two days (Sheehan and Hoy, 1999). The higher percentage of completed responses for this study within one day may be attributed to the increased prevalence of the internet today compared to previous studies, and the nature of this survey is unique in the time sensitivity of the response compared to other studies. A large spike is seen around the 150 hour mark, which correlates with an email sent reminding individuals to complete the survey. Approximately 16 percent of the responses were collected after the reminder email was sent. When comparing the time between the last email sent and the completion
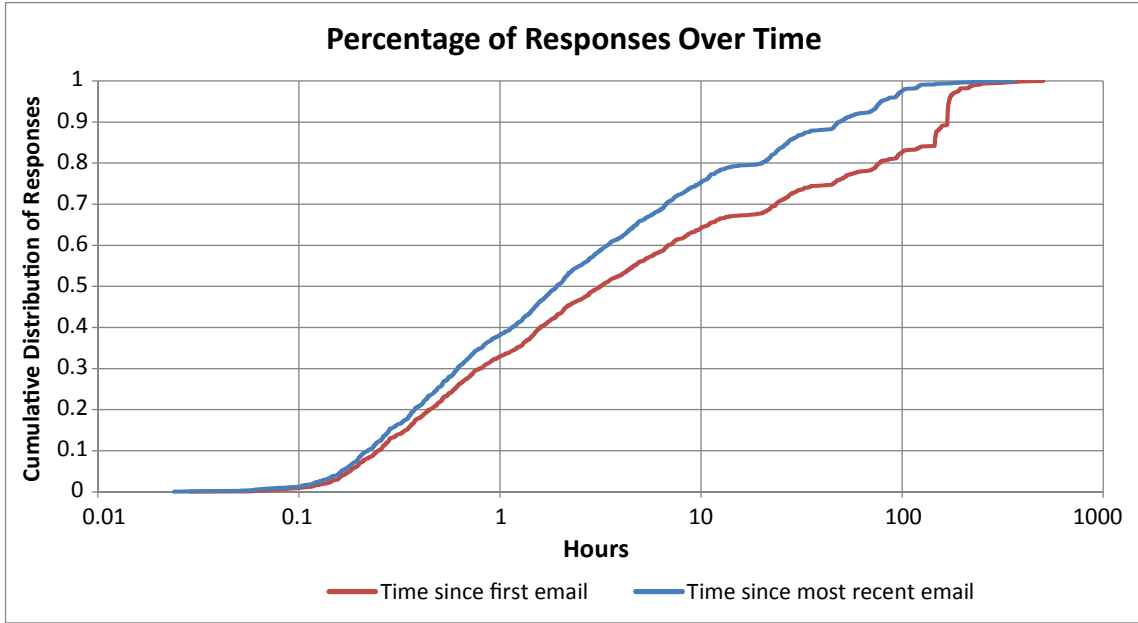
Figure 4-2: Distribution of Survey Responses Over Time

of the survey of the respondent, 80 percent of responses were submitted on the same day the email was sent, with only 20 percent of responses occurring after the initial day of distribution. The reminder email does prove to be an effective method of increasing the number of responses, although this only accounts for less than a fifth of total responses collected. At no monetary cost for sending additional email, the benefits of reminder emails strongly outweigh any negligible costs. Tests can also be conducted in the future to determine how the response rate changes based on the time between the initial email and the reminder email. However, care must be taken to ensure that these emails are not sent so frequently that they are perceived as spam and reduce future response rates.

4.4 Distribution of Completed Trip Segments in the Customer Satisfaction Survey

A comparison was done to see how the trip segments specified in the customer satisfaction survey compared with overall MBTA ridership patterns reported in 2010 (MBTA, 2010). Individual trip segments by each respondent were tabulated and compared to ridership based on unlinked trips made in the system. As seen in Table 4.4, Commuter Rail is over-represented in the customer satisfaction survey compared to

general ridership by approximately 10 percent, while Green Line and bus trip segments are under-represented by 6 and 7 percent respectively. The other services that the MBTA provide are reasonable in the proportion of trip segments made compared to past overall ridership counts. This disparity also shows one way that the prompted recall approach using AFC transactions can enhance online surveys by identifying any routes that are undersampled and, using prior trip records, identify individuals who use specific lines to be surveyed.

Table 4.4: Survey Usage by Mode and MBTA Ridership (2010)

Mode	% Surveyed Segments	MBTA Ridership (2010)
Subway	54.9%	58.0%
Red Line	22.2%	19.5%
Orange Line	15.7%	14.9%
Blue Line	3.4%	4.6%
Green Line	13.4%	19.0%
Bus	22.8%	30.2%
Silver Line	2.6%	2.4%
Commuter Rail	19.2%	10.7%
Other	0.4%	1.1%

4.5 Distribution of New CharlieCard Holders

As seen in section 3.5.3, there are a significant number of respondents who report using multiple CharlieCards as fare payment. In addition, given the large percentage of commuter rail users, prior trip history becomes difficult to analyze with CharlieTickets that vary each month. Therefore, the customer satisfaction survey asked users when completing information about a previous journey whether the respondent used a different CharlieCard to complete the trip compared to the one provided in the initial recruitment survey. The results of this question are shown in Table 4.5.

Over half of the individuals in the General - Unlinked survey group reported using a different second CharlieCard or CharlieTicket to complete the journey specified in the survey. This number was much lower for individuals with a confirmed record within the past week, with only 6 – 7 percent of respondents reporting a new fare card to pay for the specified journey. As mentioned above, commuter rail users typically obtain new magnetic stripe fare tickets each month for monthly passes, so further analysis

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Table 4.5: Percentage of Surveys Indicating New Fare Payment Cards

	Gen. - Unlinked		Gen. - Linked		Prompted Recall		Total
Same Number	233	48.6%	385	92.8%	392	94.0%	77.0%
Different Number	246	51.4%	30	7.2%	25	6.0%	23.0%
(excl. commuter rail)	Gen. - Unlinked		Gen. - Linked		Prompted Recall		Total
Same Number	92	54.1%	359	97.0%	375	96.4%	88.9%
Different Number	78	45.9%	11	3.0%	14	3.6%	11.1%

was conducted excluding these users. Even without the effects of the commuter rail passes, approximately 46 percent of the respondents who did not have a trip record one week prior to survey distribution reported using a different fare card to complete the journey, the most likely reason that no trip was recorded on the original fare instrument reported in the recruitment survey. Excluding all commuter rail users did reduce the overall percentage of respondents reporting a different CharlieCard from 23 percent to 11 percent. However, this result is quite similar to results from the recruitment survey, where approximately 17 percent of respondents reported using multiple CharlieCards to pay fares.

4.6   Comparison of the MBTA Agency Rating

One primary goal of these surveys is to measure the change in how the public perceives the MBTA as a whole over time. As this question is tracked over time, it can possibly correlated to changes in fares, quality of service, or non-agency related factors such as weather. However, the placement of this question within the survey may also influence how an individual rates the service. To test this hypothesis of the question location influencing the result, the question asking individuals to rate the MBTA was placed both at the beginning and the end of the survey. The wording of the question was not altered between the two instances of the question. The results of the two MBTA rating questions are shown in Figure 4-3, along with the rating of the specific journey described in the survey, the likelihood of the respondent to continue using the MBTA, and the likelihood that the user would recommend the MBTA to others.

Overall, 66 percent of people rated the MBTA in a positive manner, with 26 percent rating the MBTA negatively intially, with an overall satisfaction score of 4.56 on a 7
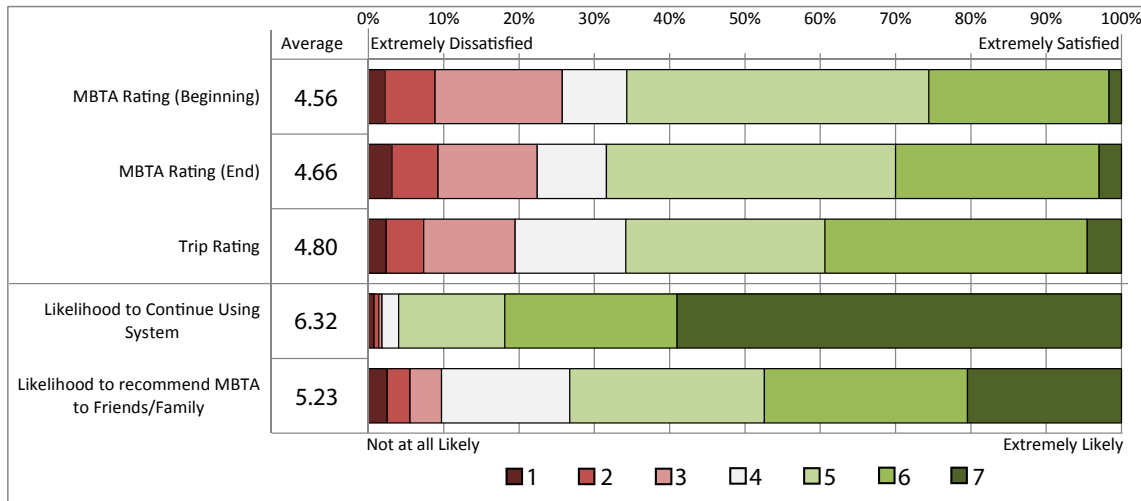
Figure 4-3: Distribution of MBTA Rating, Trip Rating, Likelihood to Continue Using the MBTA, and Likelihood to Recommend the MBTA to Friends and Family

point scale. At the completion of the survey, the average satisfaction score increased to 4.66 on a 7 point scale, with 69 percent of MBTA customers giving a positive rating. This increase in average rating was significant at both the 5 percent and 1 percent levels of confidence. Overall, 24 percent of responses increased their rating of the transit agency, while 16 percent decreased their rating. A histogram showing the difference in MBTA rating from the beginning of the survey to the end of the survey is shown in Figure 4-4. The rating associated with the specific trip made in the survey exceeded that of both MBTA ratings at 4.81 out of 7. Given that the overall MBTA rating at the end of the survey is closer to the journey rating, it is recommended that the overall rating should be asked only at the end of the survey in versions of the customer this iteration of the question should be kept, and the rating of the MBTA at the beginning of the survey removed from future versions of the customer satisfaction survey.

The survey responses were compared, both month-to-month and by survey type, to ensure stability in the survey. If survey responses widely vary among the three groups or from month to month, then any comparisons of the groups become more difficult. Tabulations of MBTA agency ratings are given in Table 4.6 by month and survey type, and the results of the tests of significance are shown in Table 4.7. Overall, as seen in Table 4.7, only general survey responses with no prior trip history in the past week had a significant difference from the Prompted Recall survey. However, this difference was not significant specifically when looking at either month. Survey
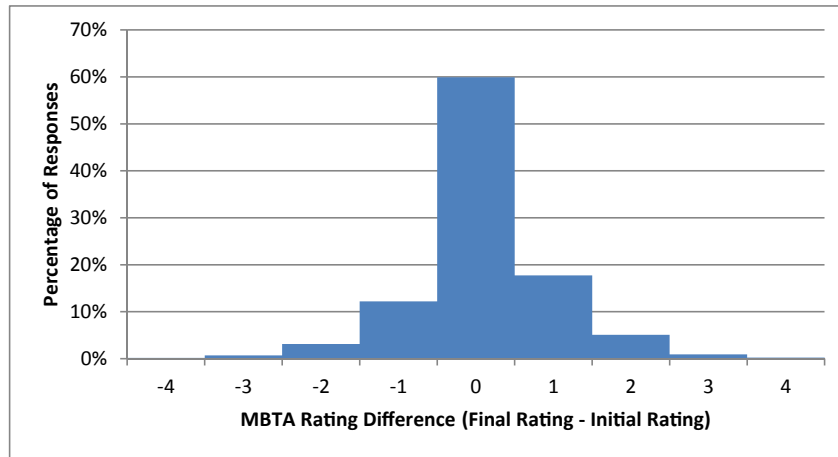
Figure 4-4: Difference in MBTA Rating from Beginning of Survey to End of Survey

results are stable between February and March across all groups as well as between Prompted Recall surveys and General surveys with a fare payment record in the week prior to survey distribution.

Table 4.6: Overall Satisfaction Rating Scores Each Month by Survey Category

MBTA Rating (End of Survey)	February				March			
	General Unlinked	General Linked	Prompted Recall	Overall	General Unlinked	General Linked	Prompted Recall	Overall
1	15	2	4	21	9	6	5	20
2	14	12	10	36	14	17	14	45
3	30	16	13	59	35	38	42	115
4	26	16	16	58	20	20	23	63
5	104	47	44	195	94	112	106	312
6	50	47	45	142	57	76	81	214
7	3	3	4	10	11	6	12	29
Average	4.455	4.727	4.743	4.605	4.629	4.698	4.774	4.704
Observations	242	143	136	521	240	275	283	798
St. Dev.	1.443	1.375	1.425	1.424	1.443	1.345	1.347	1.376

Table 4.7: Results for Statistical Comparisons for Rating of the MBTA

	Comparison	Significant @ 5%	t-value
Feb vs March for All Surveys		No	1.268
Feb vs March for General - Unlinked		No	1.328
Feb vs March for General - Linked		No	0.208
Feb vs March for Prompted Recall		No	0.218
Gen - Unlinked vs Prompted Recall for All months		**Yes**	2.358
Gen - Unlinked vs Prompted Recall for February		No	1.87
Gen - Unlinked vs Prompted Recall for March		No	1.185
Gen - Linked vs Prompted Recall for All months		No	0.590
Gen - Linked vs Prompted Recall for February		No	0.092
Gen - Linked vs Prompted Recall for March		No	0.664

Survey results were also analyzed based on whether the respondent had an employer-sponsored pass. As mentioned in section 3.5.3, individuals receiving some form of employer subsidy have different ridership characteristics compared to the general population. Results comparing these groups are shown in Table 4.8. Respondents having an employer subsidy on average had a lower rating of the MBTA compared to individuals who did not report any employer subsidy. However, the difference between the rating of individuals with employer provided passes was not significant at the 5 percent level when compared to all surveys.

Table 4.8: MBTA Rating Compared by Availability of Employer Subsidy

MBTA Rating (End of Survey)	No Employer Pass	Employer Debit	Corporate Pass Program
1	17	6	18
2	41	14	26
3	68	28	78
4	50	17	54
5	248	63	198
6	192	39	125
7	26	4	9
Average	4.793	4.462	4.573
Observations	642	171	508
Standard Deviation	1.386	1.448	1.373
5% Significance vs. Overall	No	No	No
t-value	1.895	1.790	1.283

A secondary set of questions looked at the likelihood of the individual to continue

using the system, as well as the likelihood that the individual would recommend the MBTA to friends or family. These results were overwhelmingly positive, with 96 percent likely to continue using the system and 73 percent willing to recommend the system to other individuals. While people may be dissatisfied with the system, they are not likely to stop using the system and take alternate modes under existing conditions. This may indicate that individuals do not have many alternatives for making trips in the region, or that the alternatives are worse than any poorly perceived MBTA service.

The agency rating summarizes the individual sentiment about a transit agency, encompassing the quality of service and the value in providing mobility to travel to work or other destinations. Ensuring this rating is as accurate as possible allows the agency to understand what improvements or problems with the system most influence customer perception. The difference in rating for the same question shows that the location of the question does influence how people respond, as the initial question likely captures the perception of the MBTA from general experiences and from the media, while the final question includes the further reflections from the survey questions. The MBTA agency rating should be placed at the end, which better reflect the respondent's attitude toward the agency given the completion of specific questions about the prior journey.

4.7 Modeling the Effects of Different Characteristics on Trip Rating

Moving this customer satisfaction survey to an online format allows for two changes to surveys to be made: questions can be made about the entire journey rather than one segment of a possible multistage trip and questions can be tailored to the respondent, with questions being omitted if they are not relevant. By conducting this survey after the entire journey has been completed, the respondent may reflect more on the journey to provide valuable feedback to the agency. This section discusses a model that attempts to explain the influence of certain factors collected in this customer satisfaction survey on an individual's rating of the completed journey.

4.7.1 Perceived Service Characteristics

The survey aims to understand the general sentiment about riding the MBTA. Six factors were chosen to include in the survey: wait time, stop cleanliness, vehicle crowding, vehicle cleanliness, speed of travel, and parking availability. These variables were included in a linear regression model to explain how a respondent is influenced for his or her trip rating, the dependent variable for this model. Parking availability was dropped from the model as it was not significant and only 450 people reported any parking availability. As seen in Table 4.9, wait time and the speed of the trip were the most important factors, while vehicle crowding also had a significant impact on a user's rating of the completed trip. The regression model suggests that if a respondent improved his or her rating of the wait time by 1 point, then on average the rating of the entire journey goes up by 0.377. Stop cleanliness was not a significant factor at the 5 percent level, while vehicle cleanliness was only significant at the 5 percent level and not the 1 percent level. The R^2 value for this model was 0.66, which indicates a relatively good fit. All signs were directionally correct, with improvements in the rating of service characteristics resulting in improvements to the overall trip rating. Zero was within the 95 percent confidence for the intercept, which strengthens the validity of the model. The results of this model suggest that people rate their journey primarily on how long they expect to wait for the train or bus, how long it takes to get to the destination, and how crowded the vehicle is. It can be hypothesized that improving these three metrics will improve the perception of the trips made, which may lead to the most signficant improvement in the overall rating of the transit agency.

Table 4.9: Regression Model for Journey Rating

	Coefficient	Standard Error	t	P> |t|	95 % C.I.	
Wait Time	0.377	0.021	18.25	0	0.336	0.417
Stop Cleanliness	0.029	0.023	1.27	0.204	-0.02	0.074
crowding	0.173	0.017	10.04	0	0.139	0.207
Vehicle Cleanliness	0.051	0.024	2.09	0.037	0.003	0.099
Speed	0.325	0.022	14.38	0	0.281	0.370
Constant	0.200	0.109	1.83	0.067	-0.01	0.415

The importance of these three metrics was echoed in many of the open-ended feedback comments. Respondents complained about overcrowding on specific lines and requested more service to alleviate these conditions. Other comments received talked

about the poor state of the vehicles in service, which often lead to breakdowns, delays, and a longer time spent in the system. Given the winter conditions during the survey period, many of the comments focused on reliability issues during cold weather. Lastly, several comments focused on requesting real-time information on the Green Line. While many customers enjoy the system of "next train" signs on the Red, Orange, and Blue Lines that display the time until the next arrival of trains, the system is not yet operational on the Green Line. This project is currently in the works and should reduce perceived waiting times for passengers. The agency should continue focusing on reducing the wait time at stops, including providing more real-time information for buses and the Green Line. Lastly, while this model shows that cleanliness of the vehicle and stops do influence satisfaction, they are secondary to the primary goal of providing fast and comfortable transport.

4.7.2 Number of Segments

Understanding an individual's route choice on the MBTA has important implications. A journey consisting of many segments has many more opportunities for delays to occur while traveling. In the survey, users were asked to input the first trip segment followed by any subsequent segments if s/he transfers. Table 4.10 shows that slightly over half of the respondents reported using the MBTA without transferring to another MBTA mode, while 34 percent used two segments and 13 percent had three or more segments on the MBTA. There is a consistent decline in the rating of the system with an increased number of segments; however, the drop in rating from individuals making additional segments was not significant compared to the rating given by individuals only reporting one segment for the journey. This was confirmed with the various values of the trip rating, with declining, non-significant results. These results may become significant over time as more responses are collected.

4.7.3 Trip Purpose

Understanding the purpose of the journey becomes important for understanding ridership patterns. Travel to and from work is much more likely to have regular patterns and higher frequencies of trip-making compared to trips made for leisure or to and from shopping. With this in mind, analysis was conducted analyzing the types of trips that are being reported in the survey. The majority of individuals made trips from

Table 4.10: MBTA Ratings by Number of Specified Journey Segments

MBTA Rating (End of Survey)	Number of Segments				2 or more segments
	1	2	3	4	
1	19	13	6	2	21
2	41	23	15	1	39
3	85	62	20	3	85
4	69	42	4	2	48
5	281	164	48	10	222
6	186	125	40	2	167
7	22	12	4	0	16
Average	4.704	4.687	4.526	4.150	4.632
Observations	703	441	137	20	598
Percent	53.1%	34.2%	10.9%	1.8 %	46.9%
Standard Deviation	1.358	1.377	1.582	1.496	1.432
5% Significance vs. 1 segment	—	No	No	No	No
t-value	—	0.2056	1.3691	1.7945	0.9296

home, with a large proportion of these individuals traveling to work. Table 4.11 shows the percentage of trips that are made from home and the percentage of responses that have individuals traveling from home to work. There is a significant difference in the percentage of trips with these two specifications between the general survey and the prompted recall survey. This is likely attributed to the specification of which trip is requested in each survey. The prompted recall approach provides information on the first trip record for the most recent day's transactions, while the general survey asks for the most recent trip made in the morning. These two survey specifications are not identical and can likely explain the higher proportion of individuals traveling from home and to work in the general surveys. As a result, there is concern that the two surveys are not as comparable with this difference in the surveyed trip. Changes to future surveys are recommended to align the general survey to reflect the definition given by the prompted recall survey. Once this change is made, then surveys can be analyzed to determine whether any difference in the purpose of the trip exists based on the survey approach taken, for which an intuitive explanation does not currently exist.

Table 4.11: Percentage of Home Based Work Trips by Survey Type

	General - Unlinked		General - Linked		Prompted Recall	
Home Based Trips	422	88.7%	359	86.5%	324	77.5%
Home-based Work Trips	368	77.3%	314	75.7%	267	63.9%

4.7.4   Access and Egress Mode

A comparison was also done to analyze how users accessed the MBTA and their destination after using the MBTA system. This may influence future policy decisions by recording the specific travel patterns of individuals who use the system. For example, if a large majority of people are using private vehicles to access the MBTA, then more parking availability or larger parking fees might be considered for station plans and the price of parking may be adjusted to better match demand. Table 4.12 lists the modes used by survey respondents to travel from the origin to use the MBTA and from the MBTA to reach the destination.

Table 4.12: Individual Access Modes for MBTA Surveyed Journeys

Access Mode	Origin	Destination
Walked directly	65.6%	91.7%
Drove or rode in a personal vehicle	29.0%	1.4%
Hubway	0.2%	0.4%
Personal bicycle	0.0%	0.1%
Private shuttle van / bus	1.0%	4.1%
Taxi	0.0%	0.4%
Other	4.3%	2.0%

Most respondents who use the MBTA walk, with 65.6 percent of individuals walking from their origin to access the MBTA and almost 92 percent walking from the MBTA to their destination. Twenty-nine percent of individuals drove to an MBTA station, with less than six percent accessing the MBTA through other means. On the destination end of the journey, 4 percent of these individuals used private shuttle buses to access their destination, while remaining modes totaled less than 4 percent of the survey response. With the two largest proportions of modes for accessing the MBTA being walking and driving, tests of significance were conducted to see whether access influenced how individuals perceived the MBTA. Table 4.13 shows that even though an individual's access mode did play a role in changing how individuals perceived the

MBTA, it was not significant. There was also no significant difference in the ratings between the two subgroups.

Table 4.13: MBTA Ratings by Access Mode

MBTA Rating (End of Survey)	Driving	Walking
1	14	26
2	26	52
3	56	111
4	36	79
5	155	322
6	85	243
7	9	28
Average	4.530	4.696
Observations	381	861
Standard Deviation	1.409	1.399
5% Significance vs Overall	No	No
t-value	1.669	-0.487

4.7.5   Available Alternatives

An interesting survey result from section 4.5 is the large disparity between the general agency rating and the likelihood to continue using the system. One explanation for the high likelihood to continue riding the MBTA service may be the lack of alternatives. One of the survey questions asked if any alternatives were available to make the specified journey. A summary of the different alternatives and the percentage of individuals who had these alternatives available is shown in Table 4.14.

A large majority of 75 percent of the respondents reported not having any alternative to make this journey. Of the 25 percent that reported an alternative was available, 15 percent reported that they could have made the trip using a personal automobile or carpooling. A smaller percentage reported having bicycling or walking as an option, at five percent each. There was a significant difference for the rating of the agency for individuals having no alternative to make the journey compared to having an alternative. Analyzing specific alternatives shows that the availability of a car as an alternative contributed most to the difference in the rating compared to no alternative.

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Table 4.14: MBTA Rating by Available Alternatives

MBTA Rating (End of Survey)	No Alt.	Alt. Available	Car	Shared Car	Walking	Biking
1	23	18	8	2	5	2
2	57	24	16	4	1	2
3	129	45	24	3	8	5
4	86	35	18	3	8	6
5	379	128	60	11	25	21
6	268	89	37	7	18	19
7	36	3	2	0	1	0
Average Rating	4.73	4.49	4.36	4.27	4.59	4.80
Observations	978	342	165	30	66	55
Std Dev	1.37	1.46	1.49	1.60	1.47	1.31
5% Significance vs No Alt?	—	**Yes**	**Yes**	No	No	No
t-value	—	2.696	3.119	1.809	0.780	0.387

4.8 Summary of the Customer Satisfaction Survey

This chapter has examined the ability to conduct passenger customer satisfaction surveys online at the MBTA in Boston. The ability to collect responses directly from the public through a direct email campaign has allowed for a rapid collection of responses. No significant difference in the rating of the agency was shown among the three survey groups. As a result, these surveys can be aggregated for analysis for future results. These survey results were also stable on a month-to-month basis, which is a good indication for the sampling procedure. Future studies will begin to look at the changes both at an aggregate level and at the individual level. With this survey being a follow up to the recruitment survey, there was a high response rate for this survey. Overall, 68 percent of individuals who were invited to respond completed a survey. This percentage was slightly higher for individuals who had trips on the respondent-provided CharlieCard and lower for individuals with no prior knowledge. This suggests that knowing that an individual had completed a recent journey can increase the response rate, although asking about a specific previous trip with surveys utilizing the prompted recall approach did not change the response rate. Two-thirds of the responses collected were within one day of the distribution of the survey. The presence of a reminder email also aided in the collection of responses, accounting for 16 percent of the surveys collected over the two month period. The quick collection of responses bodes well for future iterations of this survey to collect large numbers of responses.

The initial analysis of the replacement or churn rate of CharlieCards shows that a sizable proportion of individuals use a different fare payment card in subsequent journeys. This complicates the distribution of prompted recall surveys, as nearly 1 in 10 individuals would not have journey records readily available for matching. As a result, general surveys with no prior AFC transaction record will still need to be distributed to the public. Even with the improvements in survey response rates from prompted recall, general surveys allow for a greater subset of individuals in the panel to provide feedback, increasing the likelihood that the sample is representative of the greater customer population.

With the knowledge gained from conducting this survey, several changes are proposed to the customer satisfaction survey. The results confirm that the placement of

questions may influence how a user may respond. It has been shown that as the respondent progresses through the survey, the individual is more likely to provide more thought about the public transit system. The agency score at the end of the survey more closely aligns with the rating a user gives to the specific journey. As a result, the question regarding the overall agency rating will remain at the end of the survey. Any disparity between the two surveys also needs to be eliminated, especially when defining trips. While the agency rating was not statistically different among the three groups, the wording of defining which journey to provide was not equivalent in the two surveys. This influenced the proportion of individuals reporting home-to-work trips in the survey, which were significantly different between prompted recall and non prompted recall surveys. Corrections to resolve this issue will strengthen the overall survey response, and eliminate any concerns about the different reporting of trips.

This survey also provided insight into how passengers perceive the service provided by the MBTA. The three most important factors for the satisfaction of the trip were shown to be the waiting time, the journey time, and the crowding of the vehicle. Other factors such as cleanliness affect the satisfaction of a journey, but are not as significant as the primary goal of transportation to move people effectively to and from locales. Other factors were also found to affect how individuals perceive the agency. Availability of alternative modes and how an individual accessed the system both showed differences in the rating of an agency, while the number of segments on a journey was not significant in changing an individual's perception of the agency as a whole.

Future work involving this survey will begin to look at the longitudinal impact of this study. As users begin to respond to this survey multiple times, individual changes in perception can be noted. This study, with both a geographically and demographically diverse panel of users, allows the agency to evaluate how service changes affect different subsets of the population.

Chapter 5

Matching Survey Responses to AFC Fare Transactions

One of the primary benefits hypothesized by using the prompted recall approach for customer satisfaction surveys is the ability to collect more complete and accurate information on surveys completed after travel is completed, especially through the verification of journey information from survey responses. If users are prompted in the survey on one segment of a previously made journey, survey information theoretically can be verified or confirmed as a user recalls this segment and others of the journey, improving the quality of the survey response. This chapter first discusses how surveys can be matched to automated fare collection (AFC) transactions and whether the responses provided in the survey are reasonable, analyzes the rates of associating survey records with fare transaction records stored at the Massachusetts Bay Transportation Authority (MBTA), and discusses some issues with matching survey records to fare transaction records.

The customer satisfaction survey asked users to specify a previously made journey made on the MBTA, using a drop down menu for information on the line or route taken for all modes, and the entry station for segments made on rail lines. Before analyzing whether trip segments were matched to fare transaction records, survey responses are analyzed to determine whether the routes specified are feasible in the MBTA system. A "feasible" record assumes, in this case, that a user would not need to walk more than a pre-described distance of 0.25 miles (400 meters) in order to access a second segment of a linked trip, if the journey consisted of two or more

segments. This assumption is based on research conducted by Gordon (2012) that inferred destinations and linked trip segments into a single journey. Next, the surveys are matched to fare transaction data to determine whether there is any record of a boarding made on the fare card on the same day of the specified journey, whether any surveyed segments can be matched to fare transaction records, and whether all segments of the surveyed journey have associated records. Commuter rail segments are excluded in this analysis as they are not part of the AFC system and therefore do not have an associated record in the fare transaction database. The hypothesis is that using prompted recall surveys will improve the rates of matching survey responses to recorded fare transactions, enhancing the quality of survey responses and understanding of journeys made within the system. With the ability to retrospectively analyze journeys through survey responses joined to service metrics such as on-time performance and loading through automated passenger counts, transit agencies are able to better understand how service quality impacts a passenger's satisfaction with public transit. With the three main qualities influencing a passenger's rating of the journey being wait time, speed, and crowding (see Section 4.5), confirming a user's journey on a specific bus or train improves the information available to make future service decisions.

5.1 Feasibility of Specified Journeys in Survey Responses

Before any survey responses were matched to fare transaction records, responses were analyzed to determine whether the complete journey specified by the respondent is logical. Survey responses were grouped into four categories: feasible journeys, plausible journeys, infeasbile journeys, and no information provided. As mentioned earlier, a feasible journey is one where a respondent provides complete information about a journey that follows the transfer parameter with the next stage occurring within 0.25 miles of the previous segment. Journeys that only require one vehicle (that is, journeys that do not involve transfers) are considered to be feasible if the information on that one segment provided is complete. Plausible journeys are defined as those that provide some information, but the available information is insufficient to determine whether the sequence of unlinked trips is logical. This usually results from a respondent not specifying the station at which the respondent transferred or which bus line was used when the bus mode was specified. Infeasible journeys are those

that are impossible to make given the transfer location specified or have consecutive trip segments that do not geographically intersect. Lastly, some individuals chose to not provide any information, either due to privacy concerns or for other personal reasons. Survey results were manually analyzed for feasibility and grouped based on all of these assumptions.

One major issue with all subsequent analysis is the prevalence of commuter rail trip segments in the survey. Because commuter rail payment records are not stored in the fare transaction database, there is no method to match survey records to any recorded trip history. As seen in Table 5.1, 64 percent of survey respondents in the General - Unlinked category had used commuter rail for at least one segment, with 42 percent using commuter rail for all segments of the specified journey. Overall, almost 18 percent of survey responses used only commuter rail to complete a journey on the MBTA, while 28 percent of responses had used commuter rail on at least one segment of the specified journey. These rates of commuter rail usage indicate, as discussed in section 4.4, that commuter rail users are overrepresented in the current panel and as a result, cannot be readily used in any prompted recall survey. As a result, the remainder of the chapter excludes individuals with commuter rail trip segments.

Table 5.1: Percentage of Responses with Commuter Rail (C.R.) Segments

	Only Used C.R.	Used C.R. for at least 1 segment
General - Unlinked	42.3%	64.3%
General - Linked	5.3%	10.8%
Prompted Recall	2.6%	6.7%
Total	17.5%	28.2%

Table 5.2: Feasibility of Journey Specified by Survey Respondent

	General - Unlinked		General - Linked		Prompted Recall	
One Segment - Feasible	84	49.1%	177	47.8%	179	46.9%
Two or more segments	83	48.5%	191	51.6%	198	51.8%
Feasible	72	86.7%	166	86.9%	180	90.9%
Plausible	8	9.6%	18	9.4%	10	5.1%
Infeasible	3	3.6%	7	3.7%	8	4.0%
No Information	4	2.3%	2	0.5%	5	1.3%
Total	171	100%	370	100%	382	100%

As shown in Table 5.2, between 47 and 49 percent of the journeys specified by the survey respondent had only one segment. These individuals are considered to have

feasible journeys, as there are no issues with transfers. Another 49 to 51 percent of the responses specified had two or more segments, which can be defined as feasible, plausible, or infeasible per the definitions earlier. Looking specifically at the responses with two or more segments, there is no signficant difference in the feasibility of journeys among the three groups, with 87 to 90 percent of these journeys having feasible itineraries. A small subset of 2 to 5 percent of responses had insufficient information to determine whether the complete journey provided was feasible. Approximately 1 percent of responses provided no information about a previous journey, suggesting that almost all journeys specified should have an associated record. It also confirms that the online survey mechanism is a reliable way to collect information on multi-segment journeys and complement onboard surveys, as approximately 90 percent of the responses provided with two or more segments are usable and verified. By knowing that the majority of survey responses had a valid journey routing, we know that customers are able to properly describe the bus routes and rail lines used through the current mechanism for online surveys.

There are several ways to reduce the number of plausible or blank responses. One simple way is to introduce a verification system in the survey that asks the user to confirm that s/he would like to leave the information blank. It is unknown from this test whether the blanks are intentional or due to some user error in entering the information, so introducing the check may solve the latter cause. Second, the union of previous fare transaction records to the survey discussed in the remainder of this chapter provides an opportunity to supplement the information in the survey by noting the logical progression of stages in the journey specified. If the journey is similar between the survey response and fare card history based on several criteria, then there exists a high likelihood that the information specified by the fare transaction record is the same as the survey response that is missing some information.

5.2   Survey Matching Rates

The next step is to determine whether the survey responses for trip segments matched fare transactions recorded on the user-provided CharlieCards. This is done by querying the database of fare transactions using one of two values: either the original CharlieCard serial number entered in the recruitment survey or a more recent CharlieCard serial number provided by the respondent in the customer satisfaction survey. All unlinked trip records were retrieved corresponding to either the date given by the

prompted recall survey or the user specified date for general surveys.

Survey records are then compared by matching either the station entry or the bus line used to complete each segment of the journey. If several fare transaction records match the survey response by line or station entry, then the record with a transaction time closest to that of the survey response is kept. This is done primarily in the case of a user with a round trip involving bus segments, where a user would have a fare transaction on both the initial journey and on the return journey. Ensuring that the fare transactions occur in the same sequence as the surveyed journey also aids in the matching of these two sources of data.

To better understand the ability to match survey data to the recorded fare payment history, the analysis conducted will look at the matching rates in two ways: matching rates by segment and by individual. Both of these methods of matching will exclude journeys with commuter rail segments to better understand how well trip segments and individual journeys can be matched. As a large proportion of journeys are made using both commuter rail and other modes of public transit, this separation allows for a better analysis of both the matching rate of trip segments and the matching rate of complete journeys. Results from the matching process are shown in Table 5.3.

Table 5.3: Rates of Matching of Survey Data to AFC Data (excluding commuter rail users)

	General - Unlinked		General - Linked		Prompted Recall	
Total Respondents	172	—	373	—	392	—
-with a complete match	46	26.7%	227	60.9%	264	67.3%
-with partial, incomplete match	12	7.0%	53	14.2%	81	20.7%
Total Respondents (1 segment)	92	—	191	—	186	—
-with complete match	24	26.1%	136	71.2%	160	86.0%
Total Respondents (2+ segments)	80	—	182	—	206	—
-with a complete match	22	27.5%	91	50.0%	104	50.5%
-with partial, incomplete match	12	15.0%	53	29.1%	81	39.3%
Total Segments	396	—	627	—	688	—
Trip segments matched	71	17.9%	338	53.9%	403	58.6%

With no verification of a recorded journey in the past week, only 27 percent of individuals excluding commuter rail users had reported a public transit journey that matched completely with the MBTA AFC transaction data. This is similar to the 22 percent of individuals that had a public transit journey match completely to Oyster card records in London (Riegel, 2013). Verification of a user's trip making in the week prior to survey distribution with the associated smart card increased the percentage of survey responses that were matched, resulting in an increase from the 27 percent match rate with no prior information to a 61 percent match rate. Informing the individual of one trip segment in the survey (i.e. prompted recall) improved this result further to 67 percent of the prompted recall survey responses having an associated record in the fare transaction database for all specified segments.

This increase in matched transactions was consistent when divided by the number of segments. Only 26.1 percent of responses had a complete match for individuals who only reported one segment for the journey. This increases sharply to 71.2 percent when prior knowledge of a trip is given. Prompting the user of a prior trip segment in the survey resulted in 86 percent of individuals having an associated record in the fare transaction database. Similar results are seen when expanding to journeys with multiple trip segments. The percentage of completely matched multiple-segment journeys increased to 50 percent from 27.5 percent when prior knowledge of a user's trip history is known. However, in this case the prompting of a single (first) segment of a journey does not improve the complete matching rate over just knowing a 2 or more segment journey was made in the past week. Larger samples should be collected in the future to determine whether the trend in single segment journeys carries over to multiple segment journeys. It should be noted that the user is specifying his or her journey given a definition of what journey the agency desires. Users may have variations on how a journey is defined, resulting in inconsistencies in journey reporting. However, there is no reason to assume that this inconsistency is more prevalent in one survey group compared to another.

There is a lower matched rate when analyzing trip segments due to transfers that occur within the system, but these results are proportionally consistent with those corresponding to the individual. With a significant proportion of transfers occurring within the subway network that do not require a second transaction to change lines, only 59 percent of segments could be verified in the prompted recall group. Verification was much lower for no information presented, with only 18 percent of approximately 400 segments being matched for individuals who were not recorded making a

public transit trip in the previous week but reported a trip in the survey.

Another rate that should be considered to validate the effectiveness of the prompted recall approach is the rate of matching surveyed trips to the initial information provided in the prompted recall survey. Results show that more than 77 percent of respondents reported a trip that corresponded with the information provided in the survey. This is consistent with the rate of matching conducted earlier in this section, and shows that most of the trips that were able to be matched were specified in the survey document. This confirms the value of prompted recall in soliciting responses for specific bus or rail lines.

There were nine survey records which had incomplete survey responses but where it was determined that the record of fare payment transactions could be used to supplement the incomplete survey response. The fare transaction database shows a relatively complete history of the usage of the system which helped to fill in information that was missing from the survey response, such as the station entry or the bus line used after transferring from a subway station. Without this information, the original survey would have much less value as the transit agency would not be able to associate the survey with a specific trip segment on the bus and would likely have to simply discard responses due to user recall or entry errors.

There were several common issues which resulted in survey responses not matching with the fare transaction records: missing segments in fare transaction records, suspect route data for some bus routes, and the input of parallel routes by a respondent. The first two issues are primarily related to the database of recorded fare transactions, while the last is an issue potentially related to survey design. A summary of the issues and the rate of occurrence are shown in Table 5.4.

Table 5.4: Reasons for Imperfect Matches in Surveys by Month

| | February | | March | |
	Number	Percentage	Number	Percentage
Missing trips in AFC data	16	5.1%	30	4.8%
Incorrect Bus Route	5	1.6%	19	3.0%
Availability of Parallel Route	6	1.9%	21	3.4%

The first issue that may cause the records to not completely match all trip segments is missing information in the fare transaction database. Sixteen individuals in February and 30 individuals in March were not matched presumably due to completely

missing records in the fare transaction database. (It has been assumed here that the respondent either would not take the time or effort to report trip segments that were not actually taken or perhaps completed the trip on a different day.) Several causes can be posited for this result. First, there may be an incomplete record of fare transactions in the central database. Occasionally records from buses might not be uploaded to the central server for several days or weeks, which poses an issue both when comparing survey responses to an incomplete fare transaction history and when presenting the information for a prompted recall survey. Second, some individuals may not have been required to tap to board a vehicle. This is plausible on crowded vehicles, especially the Green Line, as users may be asked to board the rear door to better distribute the crowds on a vehicle. Lastly, a trip segment might not be found on the reported CharlieCard if the user has multiple CharlieCards and taps a valid secondary but unreported CharlieCard. The respondent may simply forget that s/he has a second card that is used when boarding a vehicle. While estimates are available for the number of respondents who use multiple CharlieCards, it is unknown what percentage of users are likely to carry multiple CharlieCards when boarding a vehicle.

The second issue that may cause an incomplete match between the two data sources is having incorrect bus route data in the records. Five records in February and 19 records in March are suspected to have correct survey data but incorrect bus route records in the fare transaction database. This suspicion arises due to the valid routing in the survey response along with a corresponding valid time of fare payment. However, the bus route recorded in the fare record is a bus route that would result in the journey being infeasible based on the definition presented earlier in this chapter. The likely cause of this issue is operator error, as the route number typically is manually input by the bus driver through logins to the farebox system over the course of the day. The error is especially likely to occur if the driver has several routes to cover on a shift and forgets to switch the route on the farebox system. This can be corrected by using the vehicle location data and correcting the information after the completion of the driver's scheduled work. A process has been started at the MBTA to correct these improperly recorded routes in the archived data.

A third issue causing an incomplete match is the availability of parallel routes for a respondent. Six people in February and 21 people in March reported using a bus route that parallels the route that is reported in the smart card fare payment record. This could be attributed to a user reporting the bus s/he usually takes while

a different bus that parallels the original route was used on the date of the surveyed trip. Another cause may be the incorrect bus route number data issue explained earlier. This potentially can be remedied through the survey by presenting more information through the prompted recall approach.

As discussed earlier, several individual responses who reported Green Line usage were not able to be matched due to missing segments in the database of fare transactions. This is seen in the fare transaction history of these users, as morning journeys were reported in the survey and missing in the fare payment history, but the corresponding return journey in the afternoon has a verified Green Line entry through a station faregate. This is likely caused by the boarding patterns of Green Line trains at surface stations, where users are likely to board the train through back doors, even though current MBTA policy is to have users board through only the front door. This policy does reduce fare evasion, but at the cost of longer dwell times, especially on crowded vehicles. Some drivers do allow all door boarding during peak ridership hours, resulting in some trip segments to be missing in the fare payment record.

The Green Line also poses a unique challenge for survey administration on the MBTA, as it operates both in a subway system with fare gates and in a street operation with onboard fare collection. As such, users of the Green Line may perceive surface stops like bus stops where users do not know the boarding or alighting stop, while subway stations have higher recall of station entries. Therefore, it becomes increasingly difficult to define 1) which line a user boards if the user is heading to a branch and 2) which station a user boarded if the user specifies a branch but boarded in a station. A user may say that s/he boarded a Green Line train only specifying the line when a station would yield more information. This reduces the "full" matching rate for Green Line passengers, as these two methods of boarding are recorded differently in the fare transaction record. Enumerating all Green Line stations will make the survey instrument more difficult to parse, so other approaches must be used. Specifying that the boarding occurred on the surface may be an interim solution to this problem, reducing the issue of individuals reporting branch line boardings in underground subway stations.

While these issues causing incomplete matches account for a small percentage of the survey responses, many of the issues are easily corrected. Having the farebox more frequently updating the central server with fare transactions not only increases the ability to match survey responses to fare transactions, but also increases the ability to understand the ridership on the system on an almost real-time basis. Correcting the

bus route records through the automated vehicle location reporting will increase the accuracy of both the survey response matching and the ridership reporting. These simple changes not only increase the rates of matching survey responses but provide collateral benefits to the agency as a whole. Lastly, further refinement of the survey instrument will better increase the information provided by the customers.

5.3 Comparison of Reported Journey Start Time to Fare Transaction Paid Time

Another way to verify the quality of responses received is to compare the start times reported by the survey instrument against the fare card paid time of the first unlinked trip record in the database of fare transactions. The survey itself asked respondents to input the time at which the entire journey started, not just when the user boarded the MBTA vehicle or entered the station. Thus, there exists a slight disparity between the two measurements of start time. Users are asked to input the start of their journey in 15 minute increments such that entering information is done easily, but this may reduce the precision of the survey response. Determining whether these two start times are comparable is the goal of this section and, if they are comparable, what can be learned from this comparison.

Because the difference between the start time reported in the survey and the first fare payment record is access time for subway and access time and wait time for buses, these values should also be analyzed when comparing the start times of journeys specified in the survey and obtained from fare transactions. Both these values are self-reported by the individual when completing the survey, so there will be some reporting bias involved, but they do give an indication of the length of time people travel to access public transit. Figure 5-1 shows a histogram of the time individuals spent accessing public transit. This is subdivided by the travel mode the individual used to access the MBTA system.

Only one in six respondents report having spent more than fifteen minutes accessing the bus stop or rail station. This is in line with expectations that a large proportion of individuals do not spend a long time accessing public transit. As the time spent accessing the station increases, the proportion of individuals driving to access the MBTA increases. As shown in Figure 5-1, all individuals who spend more than 25 minutes accessing the MBTA do so by driving. Including the wait time spent for
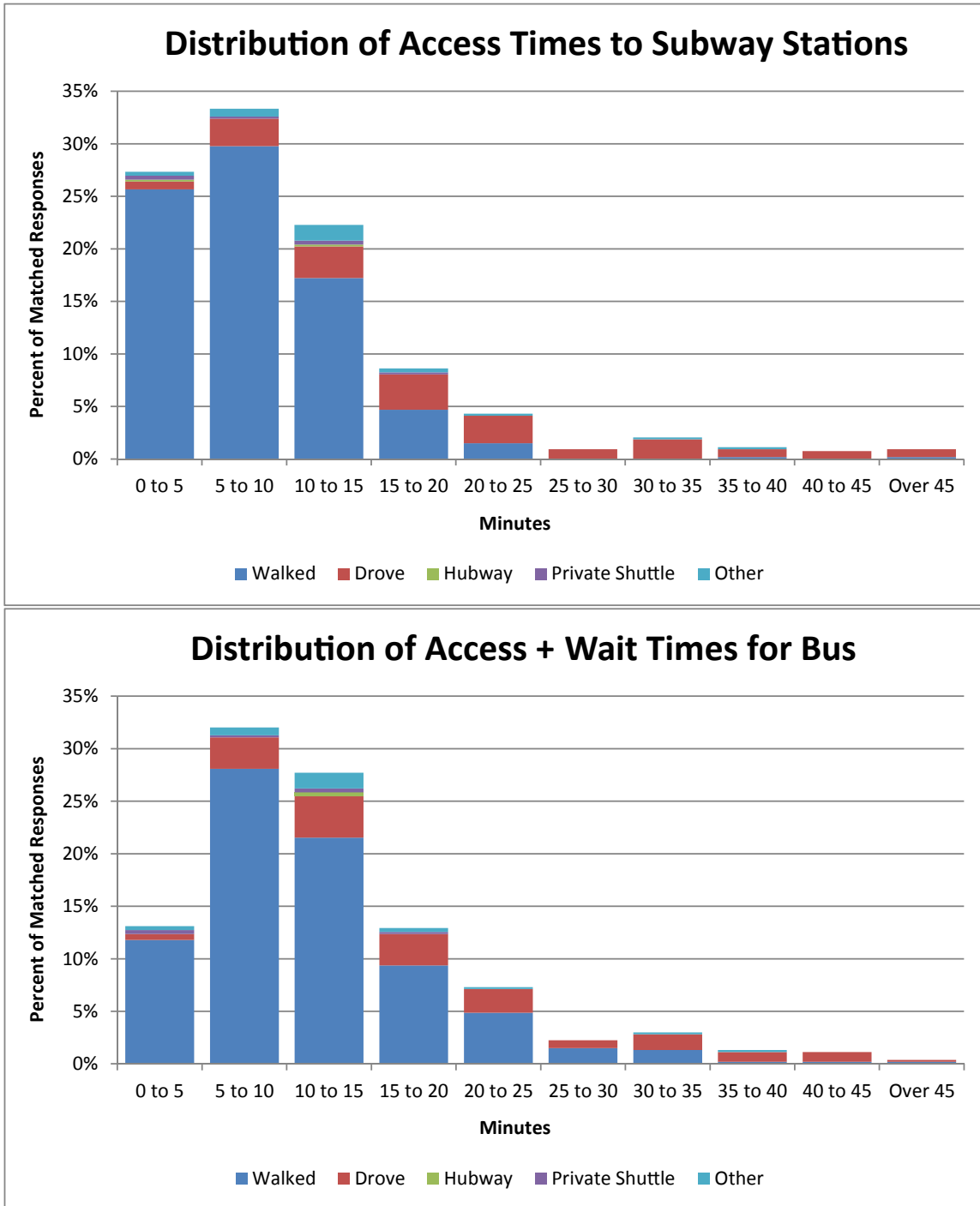
Figure 5-1: Distribution of Access Times for Completely Matched Trips by Access Mode

waiting for buses results in a drop in the proportion of sub-5 minute responses with a corresponding increase in the 10 and 15 minute categories. With a reasonable distribution of access times, these values are used to correct for the difference in the definition of the two start times to get a comparable measure for start times on public transit.

Figure 5-2 shows the distribution of start times for the survey response and the fare transaction record. Only individuals with a complete match between the survey response and fare transactions were considered in this analysis, as partial matches cannot be guaranteed to be providing information about the same trip. Based on the shape of these two histograms, there is not an obvious difference between the two graphs, with only minor outliers appearing in the recorded AFC history. To determine the similarity of the reported and recorded trip times, the difference between the AFC record and the survey reported start time is calculated, shown in Figure 5-3.

Without any corrections to access time, 34 percent of the surveyed start times were within 10 minutes of the recorded fare transaction. This is likely due to the time spent accessing the system and for those boarding a bus, the wait time at the stop. By incorporating this access time into the calculation, 58 percent of responses were within 10 minutes of the trip record. These rates compare favorably to that of comparing survey start times in London, where less than 40 percent of trips were reported to be within 10 minutes of the recorded start time.

While only a moderate proportion of initial trip segment records are within 10 minutes of the corrected survey start time, this proportion can possibly be increased given a more accurate estimate of the time spent accessing the system. Nevertheless, outliers do exist, with approximately 10 percent of responses being having a difference of over one hour. Eight responses (or 1.5 percent of the sample) had a deviation of approximately 12 hours, which likely indicates confusion between morning and afternoon in reporting the beginning of the journey in the survey. The remainder of the responses are unlikely to have matched journeys, based on the inconsistent difference in the two times. This result shows that more work needs to be done to compare survey journey responses with the AFC transaction data, as even completely matched trips may have significant differences in reporting, reducing the number of survey journey responses matched to trip records.
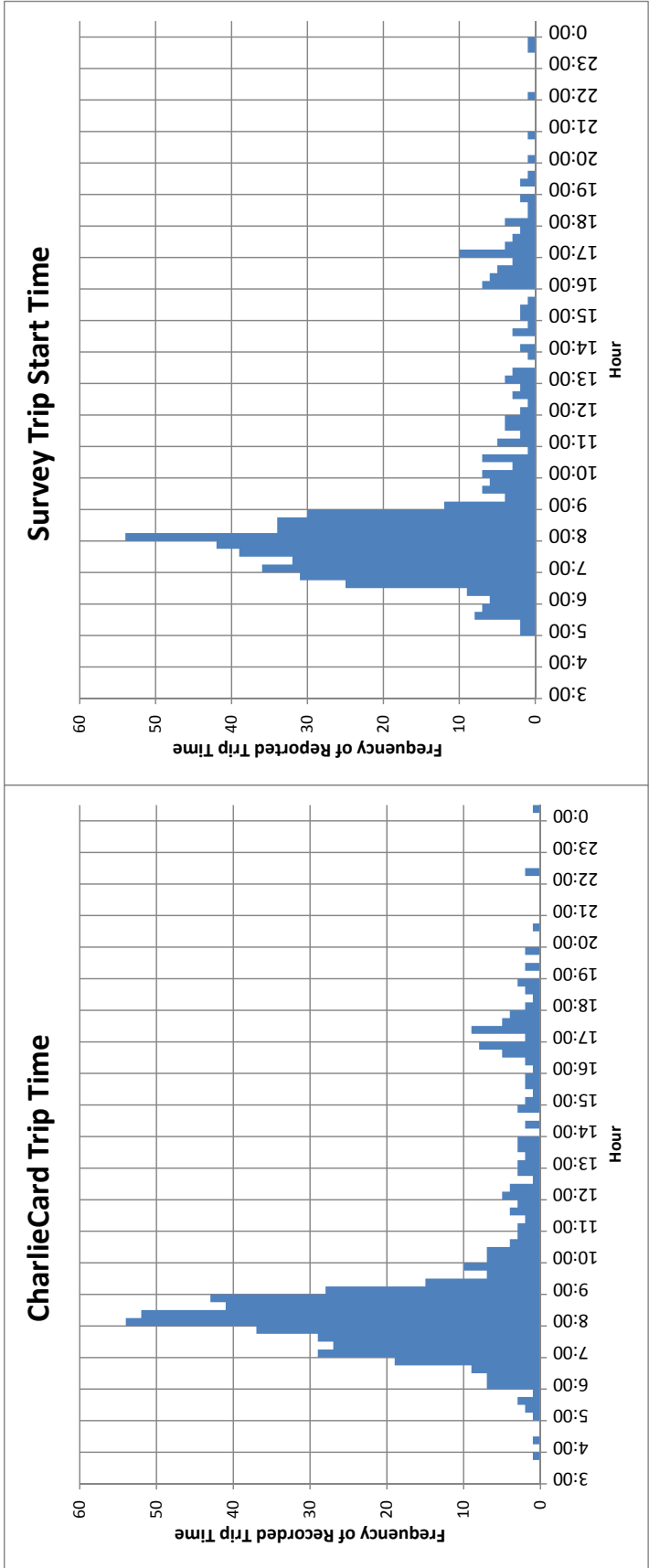
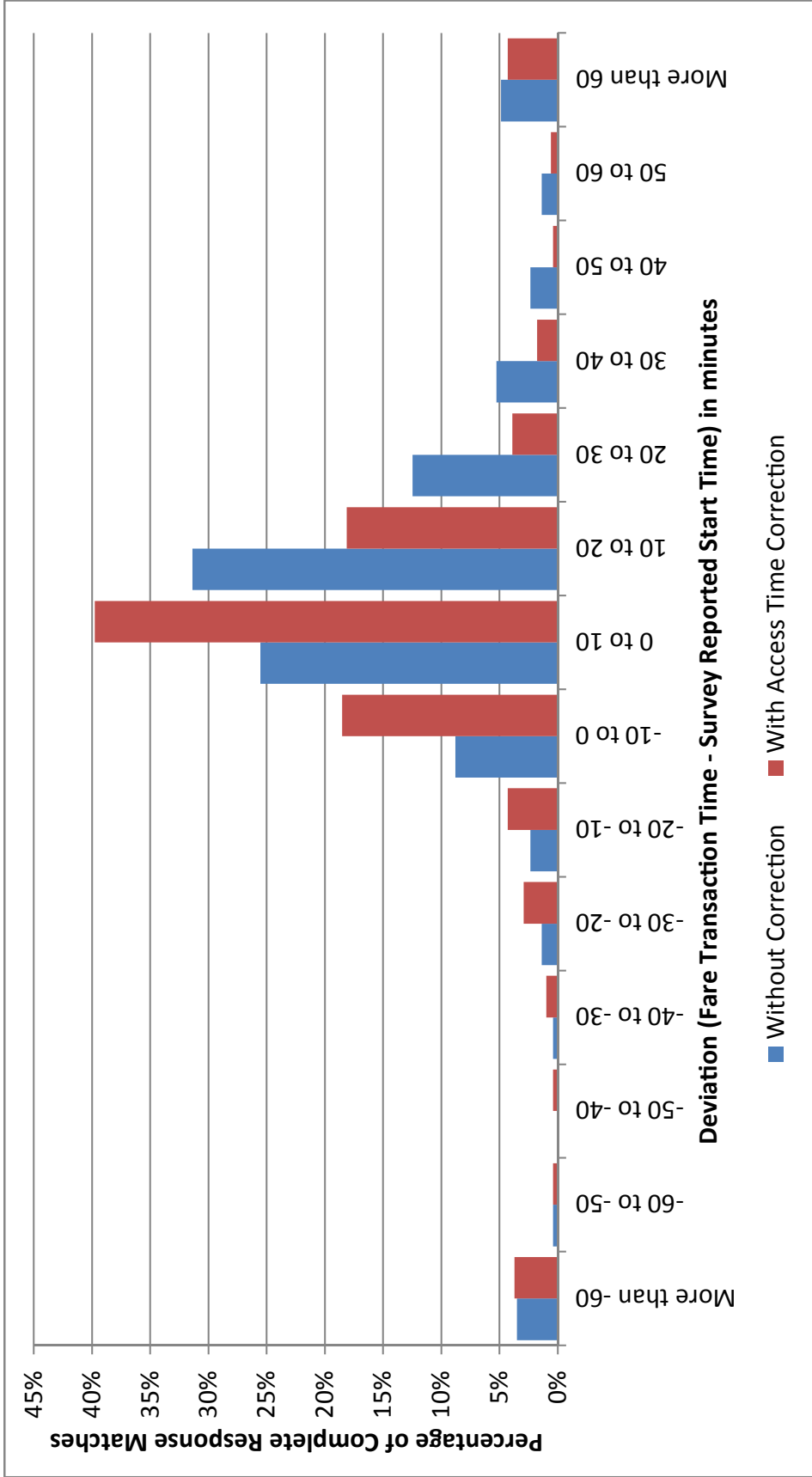Figure 5-2: Comparison of Start Times for Fare Transaction and Survey Report

Figure 5-3: Difference in Survey Response Time to Fare Transaction Record

5.4 Summary

This chapter looked at whether the prompted recall approach was a viable way for improving the quality of responses through increasing the percentage of responses matched to fare transaction records. To that end, prompted recall did improve the matching rate significantly beyond having no prior information, but a large portion of the increased matching can be captured simply by noting whether the respondent used the MBTA system in the past week. The incremental value of the prompted recall process does yield benefits beyond not providing any information in the survey, especially when the transit agency would like to ask about a specific completed journey. Over three quarters of survey responses reported on a trip involving the segment given in prompted recall, with others not being matched due to omission of that segment or reporting on a different trip. These results should be verified in the future given a more consistent definition of which journey to report in the survey response. Specifying a journey in the morning is different from both the first journey of the day (as defined for the prompted recall approach) and the most recent journey may result in slightly higher rates of matching, especially if these journeys are more irregular.

The process of matching user data to fare transaction records highlighted two classes of issues: issues with the survey response and with the fare transaction database. The former occurs primarily in reporting incorrect segments, especially if the trip segment was made on a parallel route to the one the respondent took. The latter is caused by inconsistent uploading of fare payment records to the database and incorrect logging of bus route numbers to the system. These three factors likely reduced the number of journeys that could be matched but can be corrected through the following mechanisms. To reduce respondent error, the prompted recall survey can be expanded to include all trip segments made on an expected journey. This requires some version of the Origin-Destination inference procedure that was pioneered by Gordon in London to determine what is the likely linked trip or full journey completed by the respondent. Having this information would reduce the possible misreporting of trip segments made on parallel lines by specifying all trip segments made. If this is not available, then providing a complete day's worth of boardings and entries to the system and asking the user to report on one journey may suffice as an interim step. However, caution should be taken if this approach is used as the confusion that may arise in what constitutes a full one-way journey.

Several steps can be taken to reduce the number of inconsistencies in the database. More frequent reporting of fare transactions from buses and light rail vehicles, either automatically through wireless network technologies or through nightly reporting at bus garages should help in gathering the data quickly and reliably. To remedy the bus route number issue, linking vehicle location data to the farebox may ensure the correct route is specified and confirmed to increase accuracy in reporting of trip segments. These small changes will benefit not only the survey but the transit agency in general as they increase the accuracy of information available for automated reporting from its automated data collection systems.

Finally, with the growth of alternate payment methods such as mobile phone payments on commuter rail, there is a possible need to integrate the various fare payment technologies within one database of fare transactions. The current lack of commuter rail payment records in the database results in a significant percentage of survey records with no method to verify whether a journey was made. The increasing prevalence of mobile phone payments and payments directly from credit cards will further exacerbate the issue, resulting in fewer matched survey records. In order to continue to make this system viable for future survey development using this approach, a system needs to be developed to integrate the reporting of different fare payment methods into one central database.

Chapter 6

Summary and Recommendations

Public transit agencies have an increasing need to understand their customers to better serve them. The research presented here provides one way for a transit agency to develop a panel of customers to provide feedback, periodically survey customers, understand where problems exist, and begin to analyze ways to improve service, all at a low cost. This thesis built the framework for developing a customer satisfaction panel at a transit agency and presented one method for improving the information collected through presenting a previous trip segment recorded on a respondent-provided transit smart card serial number (the prompted recall approach). An initial survey was conducted to gather information about the users so that different panels of customers can be developed to survey based on their common user characteristics. Two monthly customer satisfaction surveys were distributed online and split into three subgroups based on whether a trip was recorded on the supplied transit card in the past week and whether specific trip information is provided in the survey to the respondent. This research goes further than prior research by first determining a user's trip history before presenting the survey to the customer to see whether the survey response can be better matched to fare collection records.

This thesis resulted in an online customer satisfaction survey being developed and conducted for the Massachusetts Bay Transportation Authority (MBTA). Like many public transit agencies around the world, the MBTA did not have a ready panel of individuals to complete repeated surveys, so one was developed and implemented for the transit agency that allows for future surveys to be distributed and individual analysis conducted to refine survey distribution. Only individuals who had completed

the recruitment survey and had agreed to be contacted for future surveys were selected for the customer satisfaction survey. Surveys that displayed specific prior information about a previous completed trip segment were only available for individuals who had provided a transit smart card (CharlieCard) serial number to analyze trip histories and had a confirmed trip made within the past week. Responses were then analyzed to see whether there was any difference between providing trip information and not providing trip information. Lastly, the trip history for each user was compared to the survey response to determine the rates of matching these two independent sources of data by segment and by individual.

This chapter looks at the conclusions drawn from conducting the customer satisfaction survey at the MBTA, provides recommendations for the continuation of survey work, and suggests future directions for research using the approach created here.

6.1   The MBTA Customer Panel

The online customer surveys required that a panel of members be constructed to be able to sample enough individuals for periodic customer satisfaction surveys. In order to do so, an initial screening survey had to be constructed to collect basic information about the respondents. The sampling for this screening survey was not random but was a "convenience sample" obtained from advertising and other types of solicitations. As such, checks were conducted to ensure that the panel is reasonably representative of MBTA ridership or of the Greater Boston population. Over 5,000 responses were collected for this panel, of which 91.5 percent agreed to be contacted for future surveys. Seventy-one percent of the panel group had an unlinked trip completed on the CharlieCard number given, which increases the ability for previous history to be used in future surveys. Collecting this screening information also allowed for analysis of the panel before monthly surveys were distributed to a subset of the panel, such that monthly distributions of surveys would be reasonably representative of the panel.

The comparison of the screening survey responses to U.S. Census data provides one method of comparing whether the panel obtained is similar to the general population. For the most part, there is an underrepresentation of minority groups, including African Americans and Hispanics as well as individuals such as senior citizens. This may also be attributed to the online format of the survey, in which case onboard

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surveys may still be needed to supplement this implementation. To make the panel responses more representative, either in-person recruitment should be established in areas with high minority populations, or a system of weighing responses to capture the appropriate proportion of MBTA ridership should be conducted. A secondary comparison looked at the fare media used by individuals to determine whether this is representative of the larger population of riders. Results show that there are strong similarities between the proportion of fare payment types in the recruited panel and the system-wide usage of each respective payment type. Biases will always exist in a survey, but this research shows that even with a convenience sample, there are significant similarities between the sample and the more general ridership patterns.

The recruitment panel process started off successfully, but the ongoing viability of this approach may be questionable. Currently the average signup rate for the panel is approximately 5 individuals per day, which is possibly smaller than the attrition rate of individuals willing to participate in the survey. Over sixty percent of individuals who signed up for the customer panel came from a one-time email to individuals utilizing T-alerts, a personalized service that provides information on delays at the MBTA. Subsequent emails to this source will not likely generate as many individuals for the customer panel. Therefore, several measures should be taken to increase the rate of individuals joining the customer panel. One way to increase the number of individuals joining the panel is to branch further into other internal initiatives that already collect customer information. As T-alerts provided the largest share of panel signups, the process of signing up for T-alerts can include a request to sign up for the customer satisfaction survey to increase the visibility of the panel among the population. Encouraging the registration of CharlieCard numbers and asking those registering to join the customer panel may also serve as a way to contact individuals to complete surveys. Lastly, staff outreach at transit stations through customer service representatives and dedicated feedback events can increase the prominence of the customer survey to transit riders. Utilizing existing staff to conduct this outreach will not significantly increase costs for the agency and will allow for the recruitment to have a continued presence. Further analysis should be done to verify the viability of other panel member recruitment methods to determine the most efficient and cost-effective approach to sustain the panel over the long term. In addition, the current methods of advertising the customer panel such as online and on board vehicles should be brought back on a regular basis since these are more likely to create a steady signup rate of passengers, given the previous trends in promoting the survey.

6.2 Using a Web-based format for Customer Satisfaction Surveys

The online customer satisfaction survey asked about the general sentiment of the MBTA as well as specific aspects of a trip either recently made and recalled or specified by the survey document. The customer panel was divided into three groups: "General - Unlinked", "General - Linked", and "Prompted Recall". The "General - Linked" and "Prompted Recall" survey groups had a recorded fare transaction on their provided CharlieCard in the week prior to survey distribution, while the "General - Unlinked" group did not have any apparently travel on their provided fare cards. The Prompted Recall survey group, in addition to confirming a trip within the past week, provides the respondent with information (boarding routes or station and time of payment) for a specific trip segment to the respondent in the survey. The response to complete the monthly email survey response has been very high, with over 3,000 responses collected, or 68 percent of surveys distributed, completed over the first three month reporting period. Analysis was done on the first two months of the customer satisfaction survey, with 1,328 responses collected in the first two month period. Knowledge of a completed journey within a week of the survey increased the response rate from 60 percent to 70 percent. Customer satisfaction of the transit agency was consistent across the three survey groups, implying a non-significant difference in the results due to the identified survey administration groups. A linear regression model was also constructed to explain the largest factors influencing a customer's satisfaction of journeys taken at the transit agency. The regression model found that the largest factors influencing a customer's satisfaction of the transit agency relate to the qualities of the service provided: waiting time for a vehicle, the speed of the vehicle, and the degree of crowding inside the vehicle. Focusing on these three factors and improving them will likely result in improved satisfaction at the transit agency.

This work also reaffirms the value of conducting surveys at low cost using the online method and provides the MBTA with another method of gathering feedback on a variety of issues from passengers. With over 1,000 free-form customer feedback comments, the MBTA now has additional information to improve service to the communities it serves. The main value of this online approach is the ability for the rapid distribution, collection, and analysis of surveys in a repeated fashion. The longitudinal observation of individuals allows for a more precise measurement of changes in individual perceptions of service and the transit agency.

Future surveys should continue to refine the wording of questions to simplify the response for individuals. For example, the initial survey placed the question asking users to rate the transit agency as a whole both at the beginning and at the end to determine what effect the survey had on the response. Given this knowledge, the duplication can be removed from future surveys. Future surveys will place the question regarding the satisfaction with the transit agency at the end of the survey after the respondent reflects on the series of questions through the survey. The two versions of the survey should also have certain wording altered such that both survey implementations (General and Prompted Recall) match in the future. This is especially important in the case of asking about a previous journey made in the system. Currently, the general survey asks about a journey made in the morning, while the prompted recall version provides information about the first trip segment recorded on the provided fare card most recent day's worth of transactions. These two specifications of journeys, while somewhat similar, may result in different journeys being reported by individuals. Future survey implementations could also include clickable maps to identify the origin and destination of a trip, allowing for more accurate data to be collected while reducing the number of questions in the survey. This could also simplify the processing of data and give opportunities to infer bus stop boarding locations.

6.3   Utility of the Prompted Recall Approach

This research looked at the value of providing a prompt of a recently completed journey in the survey to obtain additional information about a specific trip. To accomplish this, fare transaction records for the individual were obtained, and the most recent day's worth of trips analyzed. The first recorded trip segment was displayed to the individual in the survey prompt, and the users were asked to respond to the following survey questions about the journey involving this trip segment. Results show no difference in the overall panel response rates between providing and not providing information about a previous trip, with response rates in both groups around 70 percent of surveys distributed. However, there is a significant increase in the percentage of trips matched to a specific fare transaction, with 67 percent of survey responses having all segments matched to the trip history provided on the CharlieCard when presented with information on a trip segment. This is a higher rate of matching compared to surveys with no prior trip information. Only 61 percent of general surveys

that had verified transactions on the MBTA within the past week and 27 percent with no verified transactions were able to be matched to actual fare transaction records, indicating that some respondents who were not prompted may have reported on a "generalized" prior trip or even a trip that they made up to simplify their response. The ability to match survey records to fare transaction data has improved customer satisfaction surveys greatly by having more information about the trip available and linked digitally. Therefore, the prompted recall approach appears successful in allowing for more (and likely better) matches to be made.

Issues do remain in terms of making the prompted recall approach successful. There are inconsistencies in the fare transaction dataset, with some transactions not appearing in the central database for several weeks. In addition several complaints were submitted to the MBTA claiming that the record presented in the survey was incorrect, leading to concerns about improper usage of the customer's transit pass by a third party. To carry out the prompted recall approach in an effective manner, data needs to be available promptly, accurately, and from all modes of public transit. Verification of the fare transaction data is crucial, as misreported automated data will invalidate the matching process and dilute the value of linking the information to the survey record. Lastly, the lack of boarding information on commuter rail vehicles reduces the value of this approach. With over ten percent of unlinked MBTA trips currently using commuter rail, having this information available is crucial to obtain a complete picture using only prompted recall surveys. With new mobile ticketing and possibly future payments made through credit cards, having a central record of all transactions is essential for the success of this type of survey.

The survey has the potential to gather tailored feedback to issues facing the transit agency. With large projects such as the reconstruction of the Longfellow bridge and Government Center Station, many customers who use the MBTA system may be inconvenienced. By having the panel of passengers who are providing access to their trip records, the agency gains the ability to track individual usage of the system and pinpoint passengers who may be required to use an affected portion of the system. The current prompted recall approach allows for individuals to be contacted regarding a disrupted trip made and collect feedback to better improve the passenger facing aspects of scheduled disruptions. At over 75 percent of respondents describing the trip given in the survey, collecting survey responses through prompted recall confirms the ability for agencies to target specific trips when conducting surveys. Further research could analyze the performance of the transit system, determine if a user is

affected by disruptions on a specific day, and have a survey distributed to collect feedback to better understand the customer impacts of the disruption, much like the surveys distributed after an airline flight.

Short of prompting each respondent about a specific trip, the ability to verify that a journey was actually made prior to the survey distribution also strengthens the survey response, as shown by the increased rate of matching survey responses to AFC data among this experimental group. With the success of this method, future surveys should always verify that passengers have recently used the transit system prior to survey distribution. As the procedure to check whether individuals in the panel have made a trip in the past week are the same as those needed to select and prompt with a recently made journey, there is little reason to not include the prompted recall approach when conducting surveys. The additional value provided by this approach for the small additional effort provides for much more complete information.

In summary, the recommendations are as follows: surveys should be distributed in two groups in following months – those with a transaction on the respondent-provided CharlieCard and those without. Individuals with a trip record should receive the prompted recall survey with one full journey given in the survey. This journey will be created using the Origin-Destination inference process adapted from Gordon's implementation in London. The general survey should still be kept as there still exists a large number of trips using commuter rail that would not be captured using this method. In addition, the general survey also allows for individuals who changed their CharlieCard between reporting cycles to provide information about a previous trip and allow the agency to link this information to fare transactions after survey completion. While this will reduce the number of trips that can be matched to AFC data, it is necessary to have a complete picture of the satisfaction in the system.

6.4 Future Work

This research has given transit agencies information to better utilize existing data to enhance travel surveys. Future work can build off this research and create better surveys to increase the amount of information available to improve service.

The development of this survey was primarily intended to analyze the customer satisfaction of MBTA passengers over the long term. With this goal in mind, surveys should continue to be distributed through the customer panel in the manner described

in the previous section. Repeated surveys should be distributed to panel members to determine what impacts any changes to the system over time were perceived by its customers and their overall impact to their satisfaction. Correlations between survey reporting periods as well as among the sample based on the service provided can improve the understanding of how passengers perceive transit service. This type of longitudinal analysis also allows for better measurements of changes in smart card turnover, with the linking of CharlieCards to an individual providing an opportunity to better understand individual travel patterns compared to the current one-card, one-person assumption. Previous research notes that attrition does occur as a longitudinal survey progresses, but it also suggests that response rates should not change as much when real incentives are offered as a part of the follow-up survey. These individuals have already agreed to complete future surveys; it remains to be seen how significant the rate of attrition will be over time.

This survey method also has the ability to strengthen the understanding of load profiles and flows within the system by providing a series of complete trip records and survey responses. This research has begun to look at the matching of individual survey records to trips made in the system, giving a sample of full itineraries in the system. The survey may provide another tool to enhance the Origin-Destination inference process designed by Gordon by being able to match specific cases from the survey to determine whether a transfer was made and at which station. This is valuable especially in the case of the MBTA's downtown stations, where transfers between all four rail lines can be made at various stations and only broad estimations of transfers between lines have been made to date. Having a user transfer at different stations between two lines can significantly change the load profile of specific trains and buses which may cause longer dwell times, causing further delays and crowding. With the Government Center Station closure altering travel patterns of many users who use the Green and Blue Lines, understanding these travel patterns would allow for better service planning to mitigate any possible rider frustrations.

Additional research should be done to quantify the impacts of different service plans on customer satisfaction, especially given future service changes and plans for fare increases. One omission of this research is the response of individuals who do not use the MBTA. Other surveys have relied on proven methods of random sampling through mail and telephone to ensure that individuals who do not use the transit system are still represented in the sample. While understanding why individuals currently use the MBTA and what can be done to improve the system is important, understanding

why former users who no longer use the system may also allow for a more complete understanding of the satisfaction of the transit agency. The longitudinal analysis presents an opportunity to understand why customers no longer use the system and what can be done to convince them to possibly use the system again. However, there was no method was proposed in this research to understand non-user behavior using this MBTA panel approach.

One potential extension of this research is examining non-user behavior through providing CharlieCards with pre-loaded stored value to randomly-selected individuals (perhaps in a specific transit corridor or neighborhood) and asking them to try the system. Bus routes could be analyzed to determine which routes are currently being underutilized and would otherwise not meet minimum service standards if the bus route had less service. CharlieCards can then be distributed to individuals who live along an underutilized bus route or rail line through a targeted outreach campaign. Individuals that live within a certain distance of the bus line would receive a mailing with an incentive of free fares on a transit smart card to try the transit system along with general information about the transit agency such as stops and route destination information. As the cards are distributed directly to residents, CharlieCard numbers would already be available for tracking to determine the effectiveness of this outreach campaign. In addition, online surveys could be distributed to understand whether this was effective in convincing users to use public transit. This experiment provides the agency with several benefits: the opportunity to increase ridership, the ability to increase the number of individuals on the customer panel, and understanding the perceptions and customer satisfaction of current non-users of the system.

Finally, the incentive offered in the survey can be varied to determine the effects of different incentives on responses. Current incentives consist of entering a lottery to win a signle monthly transit pass that covers local bus and subway fares. With the large proportion of commuter rail riders who likely still need to purchase fares for commuter rail trips on top of the monthly transit pass, these individuals may not find the incentive appealing enough to complete the survey. Larger incentives or multiple pass "prizes" that cover the most recent transit pass used may increase the response rate further. With the current survey approach enhancing the ability to combine survey response data to fare payment data, a user's previous fare purchases can be analyzed and incentives tailored to the user such that responses can be collected. The effectiveness of this personalization should be studied against the increased costs and efforts of analyzing fare payment types.

Appendix A

Recruitment Survey

Massachusetts Bay Transportation Authority

MBTA Customer Opinion Panel Signup

Thank you for your interest in the MBTA customer opinion panel. The MBTA customer opinion panel gathers ongoing feedback from our customers in order to better serve you. Surveys will be sent approximately every 3 months, with a chance to win a Monthly LinkPass each survey period.

Si quiere participar en la encuesta en español, haga clic aquí.

Privacy Statement

This survey is confidential and conforms to the Privacy Policy on the MBTA Website. Any information entered will not be sold or distributed to any unrelated third party.

We estimate that this initial survey will take you approximately five (5) minutes.

Figure A-1: Recruitment Survey Introduction

✱1. What is the number of the CharlieCard/CharlieTicket you used most recently? If you do not have a CharlieCard or a CharlieTicket, enter 0.

See below for the location of the CharlieCard or CharlieTicket number.

CharlieCard: Enter This Number

CharlieTicket: Enter This Number

✱2. What is your email address?

✱3. May the MBTA periodically email you surveys about your travel?

☐ Yes, I may be contacted at the email address provided

☐ No, I do not wish to be contacted

Figure A-2: CharlieCard and Email Information with Opt-in Agreement

✱4. How often do you use the MBTA?

○ 5 or more days a week

○ 3 or 4 days a week

○ 1 or 2 days a week

○ Less than one day a week

○ Never

5. Is the CharlieCard/CharlieTicket number you entered in Question 1 the only way you pay MBTA fares?

☐ Yes, this is my only way I pay my MBTA fare

☐ No, I have another CharlieCard/CharlieTicket

☐ No, I also pay with cash on board a bus, ferry, or commuter rail train

✱6. Do you currently receive an MBTA pass through your employer? If so, how?

○ No

◉ Yes, directly through my employer (Corporate Pass Program)

○ Yes, through a transit debit card, commuter check, or similar program

Figure A-3: Questions on MBTA Usage

✱ 7. What is your Home Address, City, and ZIP Code? (Addresses may be approximate)

Street Address: [   ]

City/Town: [   ]

*ZIP Code: [   ]

8. What is your age?

- ○ 18 or under
- ○ 19-24
- ○ 25-34
- ○ 35-44
- ○ 45-64
- ○ 65 or over

9. What is your gender?

- ○ Male
- ○ Female
- ○ Other / Prefer not to say

10. How do you self-identify by race? (Check all that apply)

- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Other (please specify)

  [   ]

11. Are you Hispanic/Latino?

- ○ Yes
- ○ No

Figure A-4: Location and Demographic Characteristics

12. Do you currently have a driver's license?

○ Yes

○ No

13. How many people (including you) currently have a driver's license in your household?

[　　▼]

14. How many automobiles (including light trucks) are available for use in your household?

[　　▼]

15. Do you currently own a smartphone? (e.g. iPhone, Android, Windows Phone, Blackberry)

○ Yes

○ No

16. What is your current household income?

○ Less than $20,000

○ $20,000-$41,999

○ $42,000-$64,999

○ $65,000-$99,999

○ More than $100,000

17. How did you hear about this survey? (Check all that apply)

☐ On MBTA.com

☐ T-Alerts

☐ From Twitter @MBTA

☐ On the Bus

☐ On the Subway

☐ From an MBTA employee at a station or bus stop

☐ Boston.com

☐ Through a family member, friend, or colleague

☐ Other (please specify)

[   ]

Figure A-5: Socioeconomic Factors and Advertising Methods

Appendix B

Customer Satisfaction Survey

Massachusetts Bay Transportation Authority

Customer Satisfaction Survey

Thank you for being part of the customer panel for the MBTA, where we gather ongoing feedback from our customers in order to better serve you. When you signed up, you agreed to let the MBTA contact you regarding your usage of the transit system. You will be given the opportunity to enter a drawing for a monthly LinkPass at the end of this survey.

Privacy Statement:
This survey is confidential and conforms to the Privacy Policy on the MBTA Website. Results will only be reported in the aggregate, and any information entered will not be sold or distributed to any unrelated third party.

We estimate that this survey will take you approximately fifteen (15) minutes.

Have you used the MBTA in the last week? *

○ Yes
○ No

How would you rate the MBTA overall? *

Extremely Dissatisfied	Very Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Very Satisfied	Extremely Satisfied
○	○	○	○	○	○	○

>>

Figure B-1: Initial Agency Rating and Usage of Transit System

Think about the **last** trip you made on the MBTA **during the morning.** If you did not make a trip during the morning recently, please tell us about the last trip you made.
A trip is considered to be a **ONE-WAY** journey with a **specific destination** in mind. (for example: going to work, school, home, etc.)

Approximately when did you leave for the MBTA bus or rail station?

	Month	Day	Time
Please Select:	▼	▼	▼

Before leaving to use the MBTA system, where did you begin this trip?

Address, Intersection, or Landmark	
City/Town	
State	
ZIP	

What type of location is this?

○ Home   ○ Shopping
○ Work   ○ Social/Entertainment
○ School   ○ Medical
○ Sporting Event ○ Other

When you began this trip, how did you get to the first bus stop or rail station?

○ Walked directly
○ Personal bicycle
○ Hubway
○ Drove or rode in a personal vehicle and parked at/near the station
○ Taxi
○ Private shuttle van / bus
○ Other (please specify)

Figure B-2: Information About the Start Time and Journey Origin

What was your final destination?

Address, Intersection, or Landmark	
City/Town	
State	
ZIP	

What type of location is this?

○ Home   ○ Shopping
○ Work   ○ Social/Entertainment
○ School   ○ Medical
○ Sporting Event   ○ Other

How did you get to your destination after leaving the MBTA system?

○ Walked directly
○ Personal bicycle
○ Hubway
○ Drove or rode in a personal vehicle
○ Taxi
○ Private shuttle van / bus
○ Other (please specify)

Did you consider using an alternative to make this trip? If so, what alternative(s)?

☐ No
☐ Yes, personal automobile
☐ Yes, shared automobile (friend, Zipcar, etc)
☐ Yes, bicycle (personal or Hubway)
☐ Yes, walking
☐ Yes, other (e.g taxi, vanpool, etc.)

On average, how many days a week do you make this trip using the MBTA?

First time making this trip	Less than 1 day a week	1 day a week	2 days a week	3 days a week	4 days a week	5 days a week	6 days a week	7 days a week
○	○	○	○	○	○	○	○	○

Figure B-3: Information About the Journey Destination, Alternatives, and Frequency of Trip

Massachusetts Bay Transportation Authority

Customer Satisfaction Survey

On which bus line or rail station did you begin your journey on the MBTA?

Rail/Bus [▾   ]

Line [▾]

Station [▾]

Approximately how much time -- in minutes -- did you spend for the following?

Time to get to bus stop or rail station [   ]
minutes

Time spent waiting at stop / station [   ]
minutes

Time spent onboard this vehicle [   ]
minutes

Did you transfer to another MBTA vehicle or line?

○ Yes
○ No

[<<]   [>>]

Figure B-4: Trip Segment Information

Massachusetts Bay Transportation Authority

Customer Satisfaction Survey

At which station did you exit? (If your final segment was on a bus, skip this question.)

Rail [▼]

Line [▼]

Station [▼]

Approximately how much time -- **in minutes** -- did it take you to get to your destination after exiting the MBTA system?

Time spent from stop/station to destination [   ] minutes

When you signed up to be a part of the Customer Opinion Panel, you provided us your CharlieCard or CharlieTicket number as [number] on [date].

Have you changed CharlieCards since then? If so, please enter the CharlieCard/Ticket number you are currently using.

○ No, I have not changed CharlieCards

○ Yes, my new number is
[   ]

CharlieCard — Massachusetts Bay Transportation Authority
5 2317623696, G0000500669
CharlieCard: Enter This Number

CharlieTicket
0107810192
CharlieTicket: Enter This Number

Figure B-5: Exit, Egress, and CharlieCard Information

Massachusetts Bay Transportation Authority

Customer Satisfaction Survey

For this trip, did you use any of the following either before or during the trip? (Check all that apply)

- ☐ MBTA.com
- ☐ T-alerts
- ☐ Real time Arrival Signage ("Countdown timers")
- ☐ Real Time Mobile Apps (e.g. Nextbus)
- ☐ Paper Schedule
- ☐ Station Maps/Bus Stop Schedules
- ☐ None of the above

For this trip, please rate the following characteristics.

	Unacceptable	Very Poor	Poor	Fair	Good	Very Good	Excellent	Not Applicable
Wait Time at Stop	○	○	○	○	○	○	○	○
Stop Condition & Cleanliness	○	○	○	○	○	○	○	○
Seat Availability / Crowdedness	○	○	○	○	○	○	○	○
Vehicle Cleanliness	○	○	○	○	○	○	○	○
Speed/Travel Time	○	○	○	○	○	○	○	○
Parking Availability	○	○	○	○	○	○	○	○

How would you rate this trip overall? *

Extremely Dissatisfied	Very Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Very Satisfied	Extremely Satisfied
○	○	○	○	○	○	○

Figure B-6: Trip Rating and Other Trip Information

Massachusetts Bay Transportation Authority

Customer Satisfaction Survey

Now thinking more generally about the MBTA as a whole, please answer the following questions.

Please rate how well we are communicating with you in the following ways

	Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Very Satisfied	Not Applicable
MBTA Website	○	○	○	○	○	○	○	○
Real time Arrival Signage ("Countdown timers")	○	○	○	○	○	○	○	○
In-station delay announcements	○	○	○	○	○	○	○	○
On-vehicle delay announcements	○	○	○	○	○	○	○	○
T-alerts	○	○	○	○	○	○	○	○
Real-time Mobile Apps (e.g. Nextbus)	○	○	○	○	○	○	○	○
Scheduled Service Interruptions	○	○	○	○	○	○	○	○

Below are a series of statements that may or may not reflect your feelings, attitudes, beliefs, or behavior when taking the MBTA. Please answer whether you agree or disagree with these statements.

	Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
The MBTA provides reliable public transportation services.	○	○	○	○	○	○	○
The MBTA uses technology to meet the needs and demands of its riders.	○	○	○	○	○	○	○
I use the MBTA because I consider myself to be an environmentally conscious person.	○	○	○	○	○	○	○
The MBTA is a cost-conscious organization.	○	○	○	○	○	○	○
The MBTA is a good value for the money.	○	○	○	○	○	○	○
The positives of the MBTA outweigh the negatives.	○	○	○	○	○	○	○
The MBTA is easy to use.	○	○	○	○	○	○	○
The MBTA has a fleet of trains and buses that are clean and well maintained.	○	○	○	○	○	○	○

Figure B-7: Ratings of MBTA Service Attributes and Attitudes Toward MBTA Service

Customer Satisfaction Survey

How likely are you to continue using the MBTA in the future? *

Extremely Unlikely	Very Unlikely	Unlikely	Neither Likely nor Unlikely	Likely	Very Likely	Extremely Likely
○	○	○	○	○	○	○

How likely are you to recommend the MBTA to a friend or colleague? *

Extremely Unlikely	Very Unlikely	Unlikely	Neither Likely nor Unlikely	Likely	Very Likely	Extremely Likely
○	○	○	○	○	○	○

How would you rate the MBTA overall? *

Extremely Dissatisfied	Very Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Very Satisfied	Extremely Satisfied
○	○	○	○	○	○	○

Would you like to be entered to win a free Monthly LinkPass?

○ Yes

○ No

Lastly, do you wish to make any comments?

Figure B-8: General MBTA Agency Perceptions and Lottery Enrollment

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