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Understanding the Needs of Current and Potential Bus Transit Riders
FINAL REPORT

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Submitted by

Devajyoti Deka, Ph.D.
Senior Research Fellow
Alan M. Voorhees Transportation Center
Rutgers University

NJDOT Research Project Manager
Stefanie Potapa

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16. Abstract
In the context of the pre-COVID local bus ridership decline for NJ TRANSIT, this research began with two primary objectives: (a) identify the needs of the current and potential bus riders, and (b) identify strategies to address the ridership decline with an understanding of those needs. Because this research began before the COVID-19 pandemic, its original intent was to assess the needs of the current riders, the riders who stopped riding the bus, and the New Jersey residents who have never used the bus. Because of the pandemic's devastating effect on public transit, the riders who stopped riding because of COVID were added as a separate category of potential riders. The major tasks for this research were a literature review, telephone interviews with representatives from several transit agencies nationwide, an online survey of NJ TRANSIT bus riders, and a combined telephone and mail survey of New Jersey residents. The literature review helped to catalog the reasons that could have caused the nationwide decline in transit ridership, the interviews demonstrated the steps agencies have taken to address ridership decline, and the surveys demonstrated the needs and barriers of the current and potential bus riders in New Jersey. The study presents a number of recommendations to address ridership decline, including a greater attention to the needs of the current riders and past riders over the needs of the riders who never used the bus; greater attention to non-discretionary bus trips over discretionary/occasional trips with a deliberate intent to increase ridership; increased focus on service in areas where bus is currently popular; improved bus frequency, reliability, and travel time; retention and improvement of service during weekday off-peak periods and weekends; examination of the potential for more direct buses to destinations to attract new riders with an emphasis on convenience and comfort; exploration of possibilities for coordinated service with ridehailing companies in off-peak periods for recreational/entertainment trips; and dissemination of bus information and marketing material for potential bus users.

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The Rutgers research team consisted of Andrea Lubin and James Sinclair of the Alan M. Voorhees Transportation Center (VTC). Ms. Lubin made serious contributions through various research activities, including surveys, reviews, editing, and activities related to the university's Institutional Review Board (IRB). Mr. Sinclair helped with survey translation and dissemination. Madelaine Corcoran and Gabrielle Krol, also of VTC, assisted with the management of the project budget and administrative tasks related to the university's Office of Research and Sponsored Programs (ORSP). Edward J. Bloustein School graduate student Ziwei Liu assisted with data cleaning, undertaking various types of GIS analysis, and preparing maps for the final report. Ye Yao, a doctoral candidate at the School, assisted with preparing email lists and related analysis.

The sub-consultant team from Foursquare ITP, consisting of Andrew Zalewski, Sofie Rhoades, and Jessica Klion, assisted with practice scan, conducted interviews with transit agency officials, wrote a task report, and helped to synthesize the study findings. The section of this report on interviews with transit agency representatives was written by the Foursquare team with only minor editing by the Principal Investigator. Dr. Ashley Koning, Assistant Research Professor and Director of the Eagleton Center for Public Interest Polling at the Eagleton Institute of Politics in Rutgers University led the telephone survey of New Jersey residents.

The entire research team is grateful to the transit agencies that participated in the interviews and provided valuable information and insights about the study's subject matter. The research team is equally grateful to the transit riders who participated in the transit rider surveys and the New Jersey residents who participated in the general population survey. The research team is immensely grateful to Susan O'Donnell of NJ TRANSIT and Stefanie Potapa of NJDOT for the significant amount of time they spent reviewing and commenting on various work products.

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EXECUTIVE SUMMARY

Background

The primary objective of this research was to identify the needs of the current and potential bus riders in New Jersey in the context of a decline in ridership for several years. Although the economy prospered between the Great Recession of 2007-2009 and the pandemic, public transit ridership began to decline a few years after the recession ended. Nationally, transit ridership might have declined by as much as 15% between 2012 and 2018. According to published sources, bus ridership decreased more than rail ridership in most places. Like many other transit agencies nationwide, NJ TRANSIT also experienced a significant decline in bus ridership. Its average weekday bus ridership decreased by 7.5% and Saturday and Sunday ridership decreased at an even higher rate in a four-year period between 2015 and 2019. This research began before March 2020, when the COVID-19 pandemic began and impacted ridership on the entire public transportation industry in the United States.

The premise of this research is that ridership decline can be addressed by retaining current riders and attracting potential riders. When this research began, potential riders were considered to be the people who never used the bus and the riders who stopped riding the bus. Thus, the objective was to identify strategies to address bus ridership decline by first examining the needs of the current NJ TRANSIT bus riders, the bus riders who stopped riding in the pre-COVID world, and the people who never used the bus. However, because of the tremendous impact of the pandemic on the transit industry, the riders who stopped riding the bus because of COVID were included as a separate category of potential riders.

This research was conducted at a time when NJ TRANSIT was also undertaking bus network redesigns in two distinct markets: the Newark region in northern New Jersey and the Burlington-Camden-Gloucester County region in southern New Jersey.[1] In contrast to those efforts, this study pertained to the entire NJ TRANSIT service area, and therefore, it did not specifically address issues pertaining to any specific geography. Furthermore, this research was almost exclusively based on surveys of past riders, current riders, and bus non-users with no component involving secondary data analysis.

The literature review conducted for this research and the interviews with representatives from transit agencies nationwide were larger in scope than the empirical component of this research because they pertained to overall transit ridership decline in the country, whereas the empirical part of this research focused only on bus ridership decline in New

[1] https://www.njtransit.com/newbus

Jersey. The literature review and the interviews revealed that other agencies have not taken recourse to special surveys to learn about the reasons for ridership decline, or to identify strategies based on current and potential riders' needs and preferences. In that regard, this research is unique because it involves a survey of bus riders as well as a survey of the general population of New Jersey.

Objectives

The primary objectives of this research were to identify the reasons for local bus ridership decline for NJ TRANSIT and to identify potential strategies to address the ridership decline based on the needs of current and potential bus riders. The specific objectives of this research were to:

(a) Examine the nature and extent of pre-COVID transit ridership decline
(b) Examine the causes of the pre-COVID ridership decline in the country
(c) Identify the approaches undertaken by transit agencies nationwide to assess ridership decline and its causes
(d) Identify the approaches undertaken by other agencies to address ridership decline
(e) Examine, to the extent possible, if the causes identified by others could also be the causes of bus ridership decline for NJ TRANSIT
(f) Compare the characteristics and needs of the current NJ TRANSIT bus riders with the characteristics and needs of the riders who stopped riding the bus and other New Jersey residents who never used the bus
(g) Identify the bus attributes that are important to the current and potential bus riders
(h) Identify the improvements that may help to retain the current bus riders and attract new riders to the bus
(i) Present recommendations to fulfill the needs of the current and potential bus riders with the intent of improving bus ridership

Research Approach and Summary of Work Performed

This research adopted a multipronged approach that included both qualitative and quantitative components. The major components of this research were the following:

(a) Conduct a review of literature pertaining to pre-COVID transit ridership decline, its causes, and transit improvements that may be able to address the decline
(b) Conduct interviews with officials from eight transit agencies located in different parts of the country to gain insights about their experiences with ridership change, causes of ridership change, approaches to understanding ridership decline, and remedial measures to address ridership decline
(c) Conduct a preliminary online survey of past rail and bus riders to gain insights about the potential reasons for riders' discontinuation of transit use
(d) Conduct an online survey of bus riders to compare current riders with riders who stopped riding the bus for COVID and non-COVID reasons with the intent to

identify the needs, barriers, and transit improvement preferences of current and potential riders

(e) Conduct a random-digit-dialing (RDD) telephone survey of New Jersey adults to compare personal and household characteristics, barriers to use the bus, and travel needs and preferences of current bus riders, the riders who stopped riding the bus before COVID, the riders who stopped riding after COVID, and New Jersey adults who never used the bus
(f) To supplement the data collected by the telephone survey, conduct a random mail survey of adults living in disadvantaged communities where contacting people for a telephone survey is challenging
(g) Analyze data from the surveys and synthesize key findings from all previous tasks to identify the needs and barriers of current and potential riders, and
(h) Present recommendations for NJ TRANSIT to address ridership decline based on the study findings

Analysis and Results

The literature review revealed that nationally transit ridership decreased between 14% and 15% between 2012 and 2018. The causes of this ridership decline have been hypothesized to be increasing ease of owning and leasing cars, falling fuel price, increasing income, proliferation of ridehailing services, greater telecommuting by workers, expanding bikeshare programs, greater availability of inexpensive parking, increasing bus travel time due to traffic congestion, and suburbanization of traditional transit users. Some metropolitan area-specific studies have concluded that growing automobile ownership among traditional transit users such as low-income people contributed the most to the ridership decline. However, a more elaborate recent study concluded that ridehailing could have had the most dominant adverse effect on transit, reducing ridership by 10 to 14% between 2012 and 2018, whereas increasing income and automobile ownership as well as bikeshare programs contributed significantly less. Only one factor over which transit agencies have direct control could have been instrumental in the ridership decline. That factor, fare increase, had a much lower effect than other factors such as ridehailing.

A variety of strategies have been recommended in recent literature to address transit ridership decline. They include the expansion of high-capacity transit, targeting service to productive times and places, restructuring transit networks, providing priority treatments, partnerships with ridehailing and carsharing companies, demand-response services, flex-route services, microtransit, as well as improvements in cleanliness, comfort, reliability, speed, wayfinding technologies, and station/stop amenities. The diverse nature and scale of the strategies indicate that they may not be applicable or feasible in all circumstances.

The interviews with representatives of eight transit agencies revealed that none undertook special-purpose research activities to assess ridership decline or its causes but directed conventional approaches to achieve those objectives. Those approaches include data

mining of transit cards, focus groups, rider panels, customer satisfaction surveys, and origin-destination surveys. The interviews also revealed that some agencies expanded service because of long-standing commitments, but those efforts were not necessarily undertaken to address ridership decline. Selected agencies undertook bus network redesigns, reallocated service, made targeted improvement efforts based on rider concerns, undertook infrastructure improvements, and took steps to improve information for riders.

The online survey of bus riders showed that the current bus riders are vastly different from the riders who stopped because of COVID and non-COVID reasons. The current riders have lower household income, lower automobile ownership and utilization rate, and lower educational attainment compared to riders who stopped riding the bus. Current riders are also far less likely to possess driver's licenses than the riders who stopped riding the bus. The reason for bus riding discontinuation most cited by those who stopped for non-COVID reasons is driving a car, indicating that access and utilization of automobiles is most likely an important contributing factor to the pre-COVID ridership decline. The fact that more than 40% of that group also mentioned acquiring a vehicle by leasing or purchasing before they stopped riding the bus also indicates that the impact of the increasing access to the automobile on ridership could have been significant.

To the extent the pre-COVID ridership decline occurred because of a diversion of bus riders to other travel modes, the online survey revealed that many more riders who stopped for non-COVID reasons diverted to ridehailing than commuter rail or light rail. Thus, the findings support the conclusion in existing literature that ridehailing could be a factor contributing to ridership decline, but they do not necessarily indicate that diversion to ridehailing is the most significant factor. Because a fairly large proportion of riders who stopped riding the bus for non-COVID reasons (about 40% of those whose life circumstances changed) mentioned that their household financial situation changed before they stopped riding the bus, one can infer that an increase in household income could also have influenced the ridership decline.

The online survey of bus riders also provided important insights about certain factors related to bus performance that were considered by the riders who stopped riding the bus because of non-COVID reasons. Their top considerations were low bus frequency, low proximity of bus routes to trip origins and destinations, long travel time of bus trips, and low reliability of departure and arrival time. Although these factors were not necessarily the causes of bus-use discontinuation, these factors certainly need attention for bus service planning. Crowding (i.e., difficulty getting a seat) was the most common bus-related consideration for the riders who stopped for non-COVID reasons, followed by lack of bus-stop amenities. However, potentially because of a significant decline in ridership caused by COVID, crowding is less of a concern for current riders. When asked about improvements that would attract them back to the bus, the riders who stopped riding for non-COVID reasons most commonly mentioned improved bus frequency, followed respectively by more direct buses to destinations, improved travel time reliability, improved bus-stop amenities, and faster travel time. One of the most important findings

of the online survey of bus riders was that a substantial proportion of all three bus rider categories—the current riders, the riders who stopped for COVID, and the riders who stopped for non-COVID reasons—believed that the frequency of buses decreased between the first time and the last time they used the bus. All three categories of riders also believed that departure and arrival time reliability got worse over time, but the proportion of respondents was smaller than the proportion for trip frequency, meaning that frequency is a greater concern than reliability.

The survey of New Jersey's general population—conducted primarily by telephone interviews and supplemented by a mail survey—showed that the New Jersey residents who never used the bus were socioeconomically quite different from the current bus riders and the bus riders who stopped riding the bus after COVID. While the current riders are the most disadvantaged in terms of income, vehicles in household, and education, those who never used the bus are the most advantaged. The only regard in which the current bus riders are more advantaged is proximity to bus stops near home. On average, they have greater proximity to bus stops than those who never used the bus and the riders who stopped riding the bus. The number of bus stops near their homes is also significantly larger.

The stark socioeconomic differences between the current riders and the riders who never used the bus indicate that the lifestyle of the latter may not conform to the use of local buses, and therefore, attracting them to the bus may be more difficult than attracting those who used the bus but stopped riding. Yet, from the fact that the current bus riders are relatively young and the people who never used the bus and the riders who stopped riding the bus because of non-COVID reasons are relatively old, one can be optimistic that bus ridership will increase with time naturally as today's young bus riders age and continue to ride the bus. However, for that to happen, the new young will need to have the same or greater propensity to ride the bus as today's young.

Like the online survey of bus riders, the survey of New Jersey's general population indicates that income and vehicle ownership are associated with bus use, but the results do not necessarily show that increases in income and vehicle ownership resulted in ridership decline. A direct association between income, vehicle ownership, and bus use can be inferred from the fact that those who currently use the bus have lower income and household vehicle ownership rate. The survey results are also consistent with the conclusion in existing literature, indicating that the proliferation of ridehailing services could have contributed to the pre-COVID ridership decline. The greater use of Uber and Lyft by the current riders compared to the other three categories of respondents suggests that the current bus riders could substitute occasional bus trips by ridehailing trips, but their continued use of the bus makes it difficult to draw conclusions about the net impact of ridehailing on bus use.

The general population survey also revealed that among the riders who never used the bus, there is a large segment that would not consider riding the bus at all. The riders who consider riding the bus are distinct from the riders who do not consider riding in one

important regard: they have greater proximity to bus stops than the other group. That raises their probability of riding the bus in the future. Those who consider riding the bus also have greater chances of riding the bus because they expressed more interest in riding if specific improvements were made to bus services compared to those who did not consider riding the bus. Among the improvements that are most likely to attract those riders are more direct buses to destinations, more frequent buses, improved bus stops and terminals, better connection between bus routes, and better connection between rail and bus.

The general population survey showed that the people who never used the bus perceive the bus as a travel mode to visit recreational and entertainment activities as well as a travel mode to go to work or school. Although providing local buses to accommodate new riders' work trips will not require substantial revisions to the current practice, accommodating their desired trips for recreation and entertainment will require new and different services. The desired bus trips by the riders who never used the bus are different from the trips made by current bus riders in two other regards: their origins and destinations are highly dispersed, and they are much longer than current riders' typical bus trips. Thus, to accommodate those trips, significant revisions will be needed in service provision philosophy. One potential adverse effect of providing such services involving dispersed destinations and long distances could be a reduction of services where service is currently popular.

The general population survey also revealed that a substantial proportion of the New Jersey residents who have never used the bus believe that their bus trips would be far less convenient, comfortable, and reliable, and more time consuming, than the travel mode they most often use, which for most people is the automobile. However, they are less concerned about the monetary cost of the trips. Addressing bus performance measures such as convenience, comfort, travel time, and reliability may thus help to attract new riders. Even if not many new riders are attracted, they will certainly help to retain the current riders because these are serious considerations for all travelers.

Conclusions and Recommendations

This research showed that the current bus riders in New Jersey are vastly different from the residents who never used the bus in terms of socioeconomic characteristics and proximity to bus stops near their home. While the current riders are the most disadvantaged socioeconomically, they have better bus stop access near their homes than non-riders. On the other hand, the New Jersey residents who have not used the bus are the most advantaged socioeconomically, but most disadvantaged in terms of proximity to bus stops near home. The riders who stopped riding the bus after COVID are more like the current riders, whereas the riders who stopped riding the bus before the pandemic are more like the people who never used the bus. Given the wide variation between the current and potential bus riders, as well as the differences between the

nature of current local bus service and the bus service desired by bus non-users, the following recommendations could be appropriate:

- Prioritize retention of current riders over attracting new riders. If income and vehicle ownership among the current bus riders increase, many of them may stop riding the bus like the riders who already stopped riding the bus. The strategy can be justified based on the association between household income, vehicle ownership, and ridership decline. While city-specific studies elsewhere have indicated that many traditional bus riders discontinued riding the bus as their income rose and they began to drive, the surveys conducted as part of this study strongly indicated an association between income, automobile use, and discontinuation of riding the bus.
- Focus on providing better service in areas already served by local buses. This strategy has been adopted by some of the interviewed agencies and recommended by the reviewed literature. The reasoning provided for prioritizing retention of current riders over attracting new riders applies to this recommendation as well.
- Pay most attention to fulfill the needs of the current riders, followed respectively by the needs of the riders who stopped riding after COVID, the riders who stopped riding before COVID, and the people who have never used the bus. This strategy can be justified based on the socioeconomic differences between the four groups and differences in bus-stop proximity among the groups. Because of their residential location in predominantly suburban areas far from the existing bus network, lack of bus stops near home, and negative perceptions about bus performance, the riders who have never used the bus will be the least likely to use the bus unless bus service is widely expanded geographically, and service quality is improved drastically.
- Prioritize bus frequency over all other transit improvements because both past riders and current riders overwhelmingly believe that bus frequency decreased between the first time they used the bus and the last time they used the bus. Furthermore, bus frequency was the variable that was considered the most by the riders who stopped riding the bus for non-COVID reasons. Whenever such improvements are made, let the customers know about the improvements so that they are aware of the efforts.
- The performance measures that should receive the most attention after bus frequency are departure/arrival reliability and travel time (i.e., trip duration). Like bus frequency, both past and current riders believe that service reliability decreased significantly over time.
- Retain and improve weekday off-peak bus service and weekend bus service because the current riders use the bus more frequently in those periods than the riders who stopped riding the bus did when they used the bus. Of particular importance should be mid-day service and late evening/night service.
- Although the people who have not used the bus indicated that they would like to use the bus primarily for work/school trips and recreational/entertainment trips, when efforts are made to fulfill their travel needs, place greater emphasis on work/school trips (which are typically peak-oriented) than recreational/entertainment trips (which are typically off-peak-oriented) because the latter category of trips cannot significantly increase overall ridership due to the occasional nature of the trips.

- Recognizing that the fulfillment of the desired trips by the people who have never used the bus will require substantial expansion of bus service to currently unserved areas, consider exclusive services between selected origin-destination pairs where service is convenient and comfortable to the riders, but also charge higher fares to recover the service-expansion costs.
- Because many riders who stopped riding the bus indicated that they would ride the bus again if more direct buses were available to their destinations, examine the bus network and potential origin-destination nodes to assess if more direct routes could generate sufficient ridership.
- Examine if coordination with ridehailing companies such as Uber and Lyft could increase the complementarity between the bus and ridehailing. Such complementarity may be more achievable for nighttime trips and recreational/entertainment trips.
- Because a substantial proportion of bus non-users indicated that they did not use the bus because they did not know how to get information about bus service, examine new information dissemination and marketing strategies to reach bus non-users.
- Consider technology improvements at bus stops/terminals as well onboard buses, including Wi-Fi services and real-time bus information for transfers to other buses and rail.
- Finally, with due consideration of the varying impacts of COVID-19 on different transit modes and regional travel markets because of household relocation, telecommuting, etc., examine market segmentation opportunities based on new research with the intent to grow bus ridership and overall transit ridership.

BACKGROUND

NJ TRANSIT is a statewide transit agency that provides bus, light rail, and commuter rail service to an area of 5,325 square miles, covering the territories of three metropolitan planning organizations: The North Jersey Transportation Authority NJTPA), the Delaware Valley Regional Planning Commission (DVRPC), and the South Jersey Transportation Planning Organization (SJTPO). Its services link various parts of New Jersey and territories north of the state to two of the largest cities of the county: New York City in the northeast, and Philadelphia in the southwest. The agency operates a fleet of 2,221 buses on 253 bus routes. Before the COVID-19 pandemic began in March 2020, the average weekday, Saturday, and Sunday bus ridership volumes for the agency were 520,100, 271,100, and 187,450, respectively. While many commuter bus routes are utilized by New Jersey workers traveling to work locations in New York City and Philadelphia, such buses are also often used by residents for trips within New Jersey. In addition, many local bus routes serve a large number of urban and suburban communities with widely different location and population characteristics. The large size of NJ TRANSIT's service area, the diverse location characteristics of the different parts of the service area (e.g., population density, job density, traffic congestion), as well as the diverse socioeconomic characteristics of populations within the service area (e.g., household income, vehicle ownership) make service delivery more challenging than agencies that provide service only within specific cities and towns, or within regions with more homogenous characteristics.

Even before the COVID-19 pandemic drastically reduced public transit ridership, the United States (US) experienced a transit ridership decline since about 2012-2014. According to two reports by the American Public Transportation Association (2018, 2019), after a steady increase since 1997, transit ridership began to decline nationally around the year 2014.[1,2] According to one of those reports, between 2014 and 2017-18, unlinked passenger trips by public transit nationally decreased from around 10.5 billion to around 9.6 billion, reflecting a decrease of 8.6%.[1] Two reports for the Transit Cooperative Research Program (TCRP) by Watkins et al. (2020, 2022) also noted a significant decrease in transit ridership at the national level.[3,4] Consistent with the national trend, NJ TRANSIT also experienced a decrease in bus ridership during that time period. Data from the agency's quarterly reports show that average weekday bus ridership decreased by 7.5%, whereas average Saturday ridership decreased by 10.2%, and average Sunday ridership decreased by 8.7% between July-September 2014 and July-September 2019.[5,6] Although rapid population growth and substantial expansion of transit service during that period led to ridership increases in selected regions of the country, the service area of NJ TRANSIT did not experience such population growth or service expansion.

One can hypothesize that transit ridership decline during the pre-COVID period could be potentially because of increasing traffic congestion caused by the economic boom following the Great Recession of 2007-09. Greater car traffic volume, increasing density of land uses, and increased e-commerce delivery trucks can decrease bus transit's travel time competitiveness. The proliferation of ridehailing companies such as Uber and Lyft,

increased ease of obtaining automobile loans, decreasing real price of new and used cars, and decreased fuel price can also be considered factors effecting the decrease in transit ridership. Greater telecommuting and availability of low-cost parking in downtown areas could be other factors affecting transit ridership. The suburbanization of populations that were traditional transit riders and their adoption of the automobile can also be considered potential reasons for the transit ridership decline. Obviously, understanding the effects of such diverse factors is challenging because places are diverse, and the effects of those factors could be different in different places. Furthermore, the effects of some of those factors could be different within the service area of a single transit agency.

For illustration, the change in average weekday ridership volume (i.e., number of trips) for NJ TRANSIT buses between 2015 and 2019 (the year before COVID-19 began in the state) is shown at the level of bus routes in Figure 1. When estimated as a percent change instead of an absolute change, the geographic pattern of change remains very similar to what is shown in the figure. Changes in average Saturday and average Sunday ridership volumes also show a similar geographic pattern. The two conclusions that can be drawn from weekday, Saturday, and Sunday ridership changes are that (a) bus routes serving a large part of southern New Jersey lost riders, and (b) ridership decreased in large numbers in and around large cities like Newark (Essex County), Elizabeth (Union County), Trenton (Mercer County), Camden (Camden County), and Atlantic City (Atlantic County). Because most of southern New Jersey is suburban in nature, the figure seems to indicate that ridership decreased in both urban centers and suburban areas.

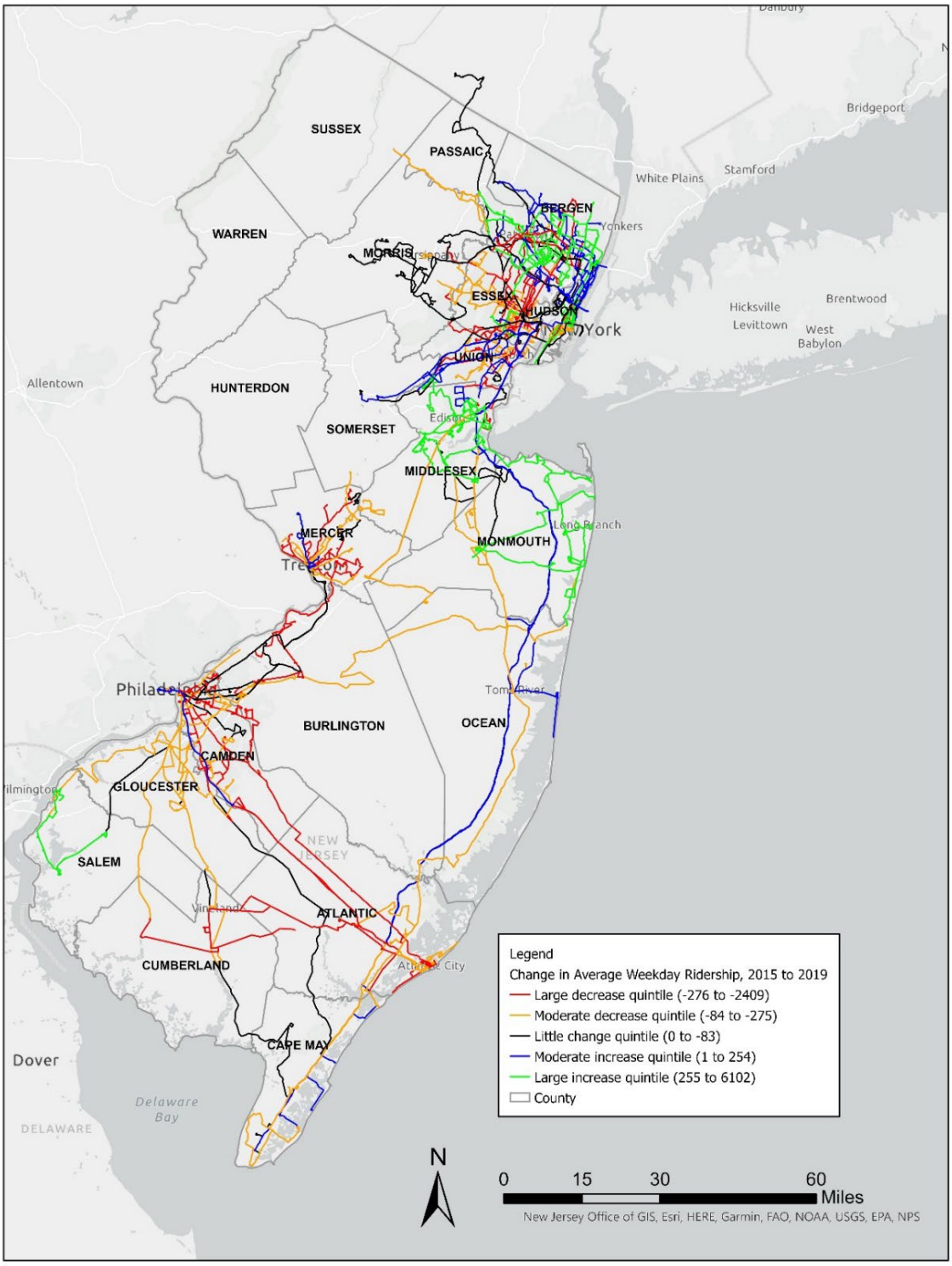


Figure 1. Change in average weekday bus ridership between 2015 and 2019

The two regions where ridership increased are Bergen County-Hudson County region in the northeastern part of the state and the Middlesex County-Monmouth County region in the east-central part of the state. Three of these four counties—Hudson, Bergen, and Middlesex—experienced significant population growth between 2010 and 2020. While Hudson County's population growth was the highest of all New Jersey counties at almost 91,000, Middlesex County ranked second with more than 53,000 increase, and Bergen County ranked third with an increase of more than 50,000. However, Monmouth County's population increased by only a little over 13,000. While the Bergen County-Hudson County region is mostly urban in nature, the Middlesex County-Monmouth County region is mostly suburban. Thus, like the places where ridership decreased, the places where ridership increased also contain a mix of urban and suburban areas, making it virtually impossible to associate the urban-suburban distinction to ridership increase or decrease.

A loss of ridership for any agency may seem like a reflection only of a failure to retain existing riders, but it also reflects a failure to attract new riders. Because changes in ridership constantly occur due to external factors such as changes in home and job location, addressing transit ridership loss requires both retention strategies as well as attraction strategies. Thus, it is important to understand the perceptions and motivations not only of current riders, but also of non-riders because those non-riders could potentially use transit if they found it an attractive travel option. Because traveling by transit is often an alternative to traveling by driving, riding as a car passenger, and riding as a passenger in ridehailing vehicles (e.g., Uber and Lyft), it is also important to understand how potential transit riders currently travel and how they value transit as an alternative to the travel modes they currently use.

This research began in October 2019 with a focus on bus ridership decline in the years prior to the COVID-19 pandemic. However, much of this research was conducted after March 2020, when New Jersey experienced its first surge of the pandemic. Because of the tremendous impact of the pandemic on public transit, especially further ridership decline caused by the pandemic, it was practically impossible to neglect the pandemic's impact in this research. In particular, the pandemic necessitated a distinction between bus riders who stopped riding NJ TRANSIT buses before the pandemic from the riders who stopped after the pandemic.

RESEARCH OBJECTIVES AND APPROACH

The major objectives for this research are to:

- Examine the reasons for transit ridership decline in the pre-COVID period in the United States and in New Jersey
- Review the strategies agencies have considered for addressing ridership decline
- Examine the potential reasons for the discontinuation of bus use by NJ TRANIST bus riders who stopped riding before and after COVID

- Compare the characteristics of New Jersey residents who have never used the bus with the riders who stopped riding the bus (before and after COVID-19) and the riders who continue to ride the bus to examine what type of services might motivate non-riders to use the bus
- Examine the preferences and perceptions of bus non-riders to identify what types of improvements might attract non-riders to the bus
- Present recommendations for retaining current riders and attract new riders to the bus in New Jersey

The research objectives were fulfilled by means of a literature review, eight interviews with transit agency representatives from around the country, a survey of past NJ TRANSIT riders (all modes), a survey of NJ TRANSIT bus riders, and a survey of New Jersey residents who might or might not have used buses in the past. The literature review helped to understand what factors might have led to the transit ridership decline nationally in the pre-COVID period, whereas the interviews helped to understand the concerns and strategies of transit agencies to address ridership decline. The survey of past transit riders was conducted to understand why the riders stopped taking transit in New Jersey. Although the current bus rider survey was originally intended to examine the needs of current riders only, because a fairly large proportion of the riders perceived to be current riders had already stopped riding the bus for COVID-19 and other reasons, the survey could also examine why some riders stopped riding the bus before and after COVID. The survey of New Jersey's general population was conducted by random-digit-dialing (RDD) telephone interviews and supplemented by a small mail survey of residents of selected disadvantaged communities. The purpose of the survey was to understand the travel patterns, needs, and preferences of the people who never used the bus and compare them with the travel patterns, needs, and preferences of riders who have stopped riding the bus and the riders who currently use the bus. Thus, much of the insights about the needs and preferences in this research were obtained by comparing people who have never used the bus, riders who have stopped riding the bus, and riders who currently ride the bus. It is worth noting at the outset that the study does not include any analysis of geographic variables (e.g., population and land use characteristics of locations) to examine their effect on ridership, travel patterns, needs, or preferences.

LITERATURE REVIEW

The objective of this literature review is to comprehend the extent of the ridership decline in the United States in the pre-COVID years, examine its causes, document the strategies that have been recommended by others to combat the decline, and discuss the transit attributes that have been found to be important for retaining and attracting riders to transit. This literature review includes three sections. The first discusses the decline in transit ridership during the pre-COVID years and its potential causes. The second discusses recommendations in recent studies to address the ridership decline. The third discusses the transit attributes that may be important considerations for retaining current riders and attracting new riders.

The Pre-COVID Decline in Transit Ridership and Its Potential Causes

As already indicated in this report, a number of recent publications have documented a decrease in transit ridership nationally.[1,2,3,4] One of these studies reported that transit ridership declined 14% to 15% between 2012 and 2018, further noting that bus ridership decreased substantially more than rail ridership during this period, but rail ridership also began to decrease beginning in 2015.[4] In addition to the national studies, some region-specific studies also reported a decline studies. Manville et al. (2018) is an example of such regional studies that examined transit ridership change in Southern California.[7]

A few reasons for the pre-COVID ridership decline have been hypothesized by existing studies.[1,2,3,4,7] They include increasing congestion, proliferation of ridehailing, increasing ease of leasing and owning automobiles, lower gasoline prices, greater telecommuting, introduction and expansion of bikeshare programs, greater telecommuting by workers, greater availability of inexpensive parking, suburbanization of traditional transit users, etc. Because public transit is often a substitute for the automobile, automobile-related variables, such as ease of owning and leasing cars, fuel price, and parking cost can be reasonably hypothesized to have contributed to the recent ridership decline. Manville et al. (2018) examined a number of factors internal and external to public transit and concluded that many factors played a role, but the most significant factor contributing to decreasing transit ridership in Southern California was increased motor vehicle access.[7] It specifically noted that an increase in car access among people with low household income was the primary reason for the ridership decline. Watkins et al. (2022) also concluded that higher rates of automobile ownership was a reason for the ridership decline, but by combining it with higher income and increase in telecommuting, concluded that they reduced ridership by only about 2%.[4] The study also concluded that average gas price decreased by about 30% between 2012 and 2018, which decreased transit ridership by approximately 4%.

Because ridehailing companies proliferated substantially during the period when transit ridership also decreased, it is not surprising that several studies have sought to examine the relationship between ridehailing and transit use. Polzin speculated in 2016 that buses would lose ridership because of ridehailing services because of the substitution effect, whereas rail transit might gain ridership because of a complementary relationship.[8] A few empirical studies provide indirect evidence that the effect of ridehailing on transit use may be negative. For example, in a national study, Deka and Fei (2019) found that ridehailing services are used far more often in neighborhoods with a high population and job density—the types of areas where transit has been traditionally more successful in attracting riders than other types of areas.[9] In studies pertaining to Seattle and Atlanta, respectively, Hughes and MacKenzie (2016) and Wang and Mu (2018) found that ridehailing is more readily available in high-density areas of cities than low-density areas.[10,11] In another study, Rayle et al. (2016) also presented data suggesting that there could be a strong trip substitution effect of ridehailing on transit.[12] Perhaps the most notable study that found strong evidence of a negative impact of ridehailing on transit was Watkins et al. (2022).[4] The study claimed that ridehailing was the most significant

contributor to bus ridership decline, potentially causing a decrease between 10% and 14% between 2012 and 2018.

A few studies examined the effect of bikeshare on transit ridership. Although they did not address the impact of bikeshare specifically on bus ridership, they can still provide some insights. One such study is Barber and Starrett (2018) for the Chicago area.[13] The study found that bikeshare trips ending near rail stations are complementary to transit, whereas bikeshare trips originating near the train station have a substitution effect on transit. The study concluded that the overall effect of bikeshare on rail transit is positive, meaning that bikeshare can help to attract riders to transit stations. Ma et al. (2015) came to a similar conclusion about the potential effect of bikeshare on transit.[14] In this study for Washington, D.C., the authors concluded that bikeshare affects the region's Metrorail positively rather than negatively. The study specifically found that a 10% increase in annual bikeshare ridership increases Metrorail ridership by 2.8%.

Instead of examining the effect of bikeshare on public transit ridership, Noland et al. (2016) attempted to examine the factors associated with the generation of bikeshare trips by using subway stations as one of those factors.[15] Although the study found that bikeshare trip generation is higher near subway stations, it does not show if bikeshare affects transit ridership. Perhaps a more important conclusion of the study is that the relationship between bikeshare and transit is so nuanced that it is difficult to examine it with publicly available data. Although Hamilton et al. (2018) does not attempt to examine the relationship between bikeshare and transit ridership, it provides some insights about the relationship in an indirect manner.[16] The study's conclusion—that bikeshare has reduced traffic congestion in Washington, D.C., neighborhoods by more than 4%—can be used to suggest that the reduced congestion should make bus operation faster, and thus make buses more attractive to potential riders. However, no study could be found that showed a direct causal relationship between bikeshare and transit ridership, let alone bus ridership. Watkins et al. (2022), the study that most comprehensively assessed the impact of different types of factors, concluded that bikeshare and e-scooters had only an insignificant effect on transit ridership.[4]

Watkins et al. (2022) concluded that an increase in transit fare was also a reason for transit ridership decline in the 2012-2018 period.[4] It maintained that bus fares increased across metropolitan areas of the country during the period of ridership decline. It found that 1% increase in average bus fare decreases bus ridership by 0.57%, whereas 1% increase in average rail fare decreases rail ridership by 0.35%.

Recommendation for Increasing Ridership

The three most pertinent studies that presented recommendations for addressing ridership decline in the pre-COVID period are TCRP Research Report 209, TCRP Research Report 231, and TCRP Web-Only Document 74, all by Watkins et al.[3,4,17] However, the recommendations are the most explicit in TCRP Web-Only Document 74,

which recommends four broad strategies that transit agencies can pursue on their own: (a) increasing transit service level, (b) adding new mobility options, (c) improving technology and customer amenities, and (d) other miscellaneous strategies.[17] For service level increase, it specifically recommends the expansion of high-capacity transit such as bus rapid transit and rail, focusing service on most productive times and places, restructuring transit networks, and providing priority treatment or dedicated transit right-of-way. The recommendation for high-capacity transit on the one hand, and the recommendation for concentration of service in the most productive places on the other, seem to suggest de-emphasizing ubiquitous service outside of dense areas but adding or expanding service to regional travel corridors.

For adding new mobility options, the study recommends partnerships with ridehailing and carsharing companies, as well as demand-response services, flex-route services, and microtransit services to bridge the first- and last-mile gaps in service. For technology and customer amenity improvement purposes, although it also mentions cleanliness, comfort, reliability, speed, wayfinding technologies and station/stop amenities such as Wi-Fi and smartphone charging stations, its two major recommendations are the integration of media technology and fare payment technology and the provision of real-time information. The miscellaneous strategies recommended by the study include fare discounts or fare elimination, bus stop consolidation, and the expansion of rail or high-capacity service.

In addition to the four broad strategies transit agencies could pursue on their own, the study recommends the utilization of transportation demand management (TDM) strategies, including transit incentives and pricing packages for Mobility as a Service (MaaS), improving access to the curb, congestion pricing, and parking pricing. Some of these strategies can be pursued only in collaboration with local and regional transportation planning authorities.

The categories of recommendations are obviously diverse. Their cost differentials could also be substantial. As a result, each recommendation may be applicable in specific circumstances only.

Understanding Rider Preferences of Transit Attributes

Understanding the rider preferences of transit attributes is important because improvements related to preferred attributes can help to address ridership decline. The review of studies on transit ridership decline in the pre-COVID period, especially the two reports by the American Public Transportation Association (2018, 2019) as well as by Watkins et al. (2020) and Watkins et all. (2022) primarily focus on external factors such greater use of the automobile, decreasing price of gasoline, proliferation of ridehailing, bikeshare programs, etc.[1,2,3,4] However, implicit in the discussions are issues related to transit attributes such as transit fare and travel time. One can argue that the attributes of transit itself should be more important considerations for transit agencies than external factors because they have little control over the external factors, but they have at least

control over attributes such as travel time, reliability, fares, comfort, convenience, frequency of service, time of service, and day of service. By addressing issues related to these attributes, agencies may be able to retain current riders and attract new riders.

One of the most commonly used guides on the topic of transit attributes is the TCRP Research Report 165 by Kittleson & Associates (2013).[17] The report describes a number of factors or attributes and assigns performance measures to each. The four categories of attributes that can directly impact people's intent to use transit are travel time, service reliability, service delivery, and safety and security. Selected performance measures for each attribute are shown in Figure 2.

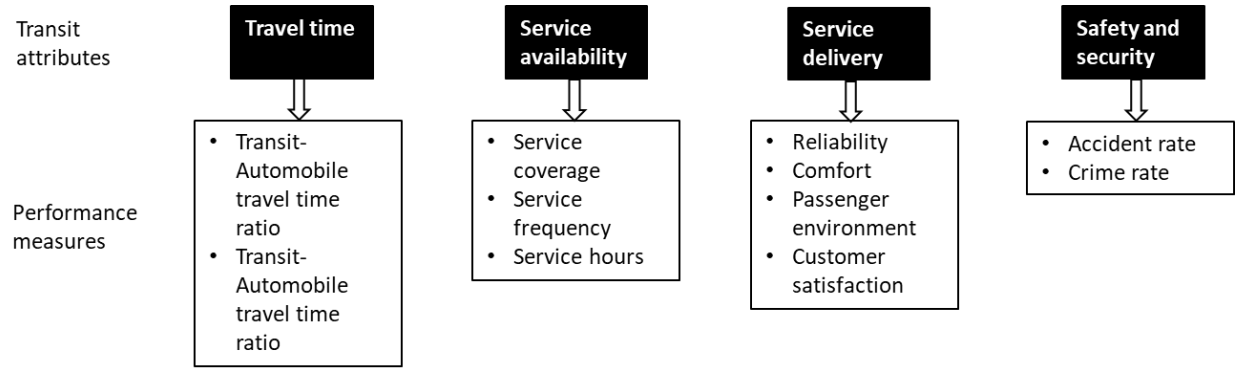


Figure 2. Attributes that can affect people's decision to use public transit

Two streams of academic studies provide insights about the importance of transit attributes to riders. One stream shows the importance of transit attributes in attracting or retaining riders, whereas the other stream shows how transit attributes relate to rider satisfaction. Chakrabarti and Giuliano (2015) and Chakrabarti (2017) fall into the first category as they examined the relationship between transit attributes and transit usage.[19, 20] On the other hand, Fellesson and Friman (2012), Abenoza et al. (2017), Abenoza et al. (2019), Cao and Cao (2017), and Grisé and El-Geneidy (2018) are examples of studies that examined people's satisfaction with or preference for a variety of transit attributes.[21, 22,23,24,25] Beirão and Cabral (2007), Eldeeb and Mohamed (2020), and Le et al. (2020) do not necessarily fall into either of the categories, but they also provide useful insights about transit attributes considered to be important by the general population and researchers.[26, 27,28]

Chakrabarti (2017) and Chakrabarti and Giuliano (2015) show that transit's travel time, headway (i.e.,, frequency), service reliability, as well as the number of transfers are factors that significantly affect ridership volume.[19,20] Beirão and Cabral (2007) considered a wide variety of transit attributes, including cost, travel time, crowding, uncertainty, comfort, waiting time, walking time, stress, relaxation, and perceptions about

the environment, but concluded from a qualitative assessment that travel time and reliability are the two most important considerations for riders.[26]

Eldeeb and Mohamed (2020) also considered a wide variety of attributes that may affect the choice of transit modes, including travel time, travel cost, frequency, on-time performance, information availability, vehicle occupancy or crowding, waiting time, proximity to stops, ease of access to stops, amenities, comfort, safety, cleanliness, staff attitude and courtesy, and customer-service performance.[27] Their models showed that fare, travel time, walking time, headway, transfer, and real-time information significantly affect the choice of public transit. However, because several of these variables were also significant when interacted with riders' personal characteristics, the authors concluded that the importance of transit attributes varies by population characteristic. For example, some attributes may be important to only low-income people, whereas other attributes may be important to only high-income people.

Most studies referenced above on rider satisfaction are important only because they list a broad array of transit attributes for researchers' consideration. However, because most of those studies were driven by the objective of market segmentation based on satisfaction with different attributes, they do not show the effect of the attributes on ridership growth or retention. Le et al. (2020) is unique in that regard because instead of examining riders' satisfaction with transit attributes or the effect of transit attributes on ridership, it examined the effect of satisfaction with transit attributes on ridership retention using panel data for the San Francisco area.[28] The study concluded that satisfaction with transit operations, which included variables such as reliability, frequency, and travel time, is statistically significant in predicting rider retention, but satisfaction with the on-board environment, which included comfort, cleanliness, safety, and crowding, is not statistically significant.

To summarize, the reviewed studies considered various types of transit attributes that may be important to riders. However, only a handful of studies show evidence that certain attributes help ridership growth or retention. The review seems to indicate that different people may prioritize the transit attributes differently. For example, for some people travel time may be the most important consideration, whereas for others it may be the monetary cost of the trip, and for others it may be on-time performance or reliability. One important point to note is that it is not merely the characteristics of the primary transit mode, but also the characteristics of the access and egress modes, that are important to riders. Another important point to note, especially for this study, is that people who do not typically use transit may not be as well-versed with the transit attributes that are important to riders. Therefore, engaging with transit non-users about transit attributes may require craft.

Conclusion

The first subsection of the literature review provided evidence of a substantial ridership decline in the United States during the pre-COVID period, showing that the ridership decline was almost universal in the country. Between 2012 and 2018, ridership might have declined by as much as 15%. The review also indicated that the decrease in bus ridership during those years was more substantial than the decline in rail transit ridership. The review showed that several factors might have caused the decline, most of which are external to the transit industry. The only attribute that is entirely internal to transit appears to be an increase in transit fare, but its effect on ridership seems to have been small. Among the external factors, the proliferation of ridehailing services seems to have had the greatest impact. Increases in income and automobile use also seems to have a discernible effect.

The expansion of high-capacity transit, targeting service to productive times and places, restructuring transit networks, providing priority treatment, partnerships with ridehailing and carsharing companies, demand-response services, flex-route services, microtransit, as well as improvements in cleanliness, comfort, reliability, speed, wayfinding technologies, and station/stop amenities are some of the recommendations in the literature to address ridership decline. The strategies that have been recommended by recent studies are broad and diverse. However, the documentation of those strategies helped to prepare a list of recommended strategies from this study. The review of additional transit attributes that were found to be important by academic studies also helped to develop the survey questionnaires and preparing study recommendations in subsequent tasks.

The reviewed literature showed that a variety of attributes affect the choice of transit modes, including travel time, travel cost, frequency, on-time performance, information availability, vehicle occupancy or crowding, waiting time, proximity to stops, ease of access to stops, amenities, comfort, safety, cleanliness, staff attitude and courtesy, and customer service performance. Understanding the relative attractiveness of these attributes in given circumstances can potentially help to address transit ridership issues.

TRANSIT AGENCY INTERVIEWS

At an early stage of this research, semi-structured telephone interviews were conducted with representatives from eight transit agencies to learn about their experiences with ridership decline, approaches to understand the causes of the decline, and remedial strategies adopted to address the decline. A list of interviewed agencies and their abbreviations are presented in Table 1. The agencies were selected based on either being a similar size and service structure to NJ Transit or due to their record of innovative practices. Prior to conducting the interviews, an interview questionnaire was prepared and—as required by Rutgers University policy—submitted for approval by the university's Institutional Review Board (IRB). Interviews were scheduled upon receipt of IRB approval.

Bus Ridership Trends

Bus ridership among all but one of the interviewed agencies (COTA) decreased in the years prior to the pandemic, although declines did not start at the same time or continue at the same rates. Some agencies experienced gradual declines that were uniform across times of day and days of the week, with losses in peak and off-peak ridership (e.g., UTA, RTD), while others experienced declines that were not evenly distributed geographically or temporally (e.g., SEPTA, MBTA).

A critical concern for several agencies was understanding the nature of the ridership loss. MBTA and MARTA cited a disproportionate decline in trips among lower-income riders. They cited potential causes of this decline, such as gentrification pricing people out of areas with good transit access and higher rates of car ownership due to subprime auto lending. MBTA cited the importance of geography and the availability of alternative modes in determining ridership declines. For example, cross-harbor routes with limited transportation alternatives managed to retain ridership better than the system overall.

There were a few key questions that agencies asked themselves when encountering ridership decline:

- Whether declines were caused by decreases in the overall transportation market as people traveled less or replaced trips with deliveries
- Whether the agency was losing market share, and if so, in what markets
- Understanding ridership losses at the route-level and time of day
- Understanding what kinds of riders (by demographic group and trip type) were being lost, and whether those riders were abandoning transit completely

Table 1 – Transit Agencies Participating in Interviews

Abbreviation	Name	Core City Served
COTA	Central Ohio Transit Authority	Columbus, Ohio
LA Metro	Los Angeles County Metropolitan Transportation Authority	Los Angeles, California
MARTA	Metropolitan Atlanta Rapid Transit Authority	Atlanta, Georgia
MBTA	Massachusetts Bay Transportation Authority	Boston, Massachusetts
RTD	Regional Transportation District	Denver, Colorado
SEPTA	Southeastern Pennsylvania Transportation Authority	Philadelphia, Pennsylvania
UTA	Utah Transit Authority	Salt Lake City, Utah
WMATA	Washington Metropolitan Area Transit Authority	Washington, District of Columbia

A key question for some agencies was whether declining ridership was due to a reduction in the number of trips taken by riders or a decline in the number of unique riders. MBTA found that it lost trips, not riders, and believes that the decline in ridership is due to riders taking fewer trips on average as opposed to leaving the system entirely. WMATA reviewed travel data from SmarTrip cards and determined that overall travel frequencies have been declining slightly in terms of trips per card per month. The distinction between riders and trips is important to understand as it could warrant different approaches to customer engagement and service planning.

Although agencies tended to have hypotheses for why ridership declined prior to the pandemic, there is no smoking gun that points to a definitive or singular cause of ridership decreases. Findings differ substantially based on city and geography, and local circumstances play a role in determining declines. Some of the major factors that may have contributed to declines in pre-COVID-19 bus ridership are explained in the following section.

Causes of Bus Ridership Decline

The interviews revealed several causes leading to the ridership decline. One of them is slowing speed. Almost every agency mentioned declining bus speeds as a key reason for ridership decline. Several agencies saw a clear correlation between the routes with worsening speeds and the greatest loss in ridership. Even when agencies took steps to improve speeds with interventions like bus-only lanes, a lack of enforcement reduced the utility of such infrastructure.

Agencies noted reliability as a leading factor behind ridership declines. MBTA found that routes with service quality issues, including speed and reliability, saw the largest declines in ridership. SEPTA noted that its longer routes were especially susceptible to reliability issues due to the compounding effect of delays and bus bunching.

Travel patterns have also changed in many of the agencies' service areas. Travel patterns changed because of changes in land uses as well as the locations of employment centers, the types of jobs that are found there, and where commuters live. Suburban job centers tend to be very dispersed and are difficult to serve with public transportation. In the Philadelphia region, there are many low-income jobs in the suburbs and those neighborhoods lack corresponding low-income housing / affordable housing so that workers can live near their places of work. Land use patterns make it difficult to help these populations commute, and car ownership is increasing throughout the region as a result. Some agencies suspect that telework may have also contributed to pre-pandemic ridership losses. WMATA reviewed SmarTrip card data and identified a decline in trip-making rates among registered cards (measured in trips/card/month).

The changing transportation landscape is considered to be another reason for ridership decline. In the last decade, shared-use modes, micromobility, and ridehailing entered the

transportation market. At the same time, subprime auto loans made it easier for consumers to finance a vehicle. These options may have caused some declines in bus ridership, but they are hard to isolate and ridehailing data are difficult to obtain. Agencies are still figuring out the extent to which ridehailing is causing them to lose trips or whether ridehailing trips are supportive of transit as first-mile/last-mile connections. Although WMATA has Capital Bikeshare trip-making data, it does not have access to detailed data about Uber and Lyft trips. MBTA is partnering with Transit App and Northeastern University to understand what makes people choose ridehailing or transit for a specific trip. Around 2018, MARTA contacted registered Breeze card owners with a survey which asked why they stopped riding and with what they were replacing transit. Pre-COVID surveys showed that ridehailing was high on the list of replacement modes. A further study validated initial findings, but the relationship between ridehailing and transit is still unclear to the agency.

Likely as relevant, if not more, to ridership trends is the rate of car ownership. Displacement of lower-income households from transit-rich neighborhoods, coupled with the availability of subprime auto lending has all contributed to increases in car ownership among lower income households. Several agencies recognized a strong relationship between car ownership and transit ridership

Demographic changes are also perceived to be instrumental by transit professionals for the ridership decline. In Atlanta, there is some evidence that current riders have been pushed out of MARTA's service area because of increasing housing costs. WMATA mentioned a similar trend in the Washington, DC region, where growth in housing prices has displaced lower-income households to suburban communities with inferior transit access.

It was noted at the interviews that poor customer information can be a barrier to non-riders and infrequent riders, making it difficult to attract new riders. In a recent survey, LA Metro found that over 90% of infrequent and non-riders were not familiar with where bus routes operate and how they connect to one another. In a survey of infrequent MARTA riders, nearly two thirds of respondents felt that bus service was not "easy and convenient to use."

Other elements that contributed to the decline in ridership can only be measured in quantitative surveys. These include the perception of safety, customer satisfaction, cleanliness of the bus and facilities, service reliability, and experiences with operators or other riders. Other intangibles of the bus ridership experience may have been contributing factors in declines, including harassment, perceptions of crime, and interactions with individuals experiencing homelessness and mental illness. LA Metro mentioned how its transit network is struggling to deal with the Los Angeles region's burgeoning un-housed population, many of whom rely on transit for shelter.

Strategies to Increase Ridership

The transit agency representatives were asked during the interviews about the strategies they had adopted to address ridership decline. The following is a brief description of their efforts.

Adding Service

Two agencies—COTA and UTA—mentioned adding services, but they were not necessarily in response to the pre-COVID ridership decline. In fact, COTA was the only agency that gained ridership in recent years. The agency's new offerings included a downtown employee bus program, a downtown circulator, and BRT. These efforts, together with network restricting and population growth, helped the agency to achieve ridership gain. However, the transit expansion in recent years was made possible by an increase in sales tax fund to transit approximately 10 years prior.

UTA, while experiencing a long-term trend of declining ridership, did experience increases in ridership that coincided with the introduction of large service expansions, such as when they opened the Utah Valley Express (UVX) Bus Rapid Transit line. On the whole, the interviews did not reveal any effort by the agencies to expand service to combat ridership decline.

Bus Network Redesigns

Many of the interviewed agencies were working on bus network redesigns to address ridership losses and assess whether the system serves rider needs. All of these efforts were initiated or completed prior to the pandemic. One key point highlighted by several interviewees is that network redesign should focus on targeting service where transit is most competitive, providing frequent service on high-demand corridors over providing extensive coverage everywhere. For example, MBTA understands that there are trip types (be it geographic or time of day) where transit struggles to compete. The agency can increase ridership by tapping into unmet needs in the locations where transit demand is highest.

UTA and RTD mentioned a similar philosophy to MBTA during their interviews. Both agencies believe they can improve ridership by expanding service for the market segments that most depend on transit, including people living in urban areas with lower car usage and higher concentrations of zero-car and/or low-income households.

Market research at MARTA concluded that certain segments of the public are unlikely to ride public transit regardless of what types of changes or investments agencies make. The 2014 MARTA Market Analysis Research study categorized approximately a third of the population as being highly unlikely to try public transit. Fifteen percent of the traveling public accounted for the majority of MARTA trips.

Reallocating Service

Several agencies felt that their services should focus less on serving peak-hour commuter needs. An earlier consultant study showed that SEPTA provided some excess peak service. In response, SEPTA removed some of the excess service and redistributed it. This adjustment provided more consistent all-day headways and created 15-minute and 30-minute maximum headway routes. At UTA, the agency recently expanded the Sunday span of service and headways on one of its busier bus lines, resulting in a 70% increase in ridership from pre-pandemic levels, indicating there was a latent unmet demand for Sunday service.

Targeted Improvement Efforts

Some agencies took a targeted approach to address specific rider concerns and to make service more attractive. LA Metro developed a Ridership Growth Action Plan to strategize on how best to address the decline. LA Metro is removing much of its limited stop bus service after research found that the short average travel distance of its bus riders meant that limited stop services increased the walk time to transit without meaningfully reducing on-board travel time for riders. They are now working on making the system easier to understand, with an emphasis on more reliable and faster local bus service.

In response to decreasing bus speeds, WMATA established a bus priority group to get the buses running faster. The agency has deployed several non-infrastructure-related strategies to improve bus ridership:

- Pilot a project to stop accepting cash on one bus route
- Lower the multiplier on the weekly bus pass to make it more affordable, as a way of cutting fares and inducing transit use
- Add bus service to the monthly select pass (primarily a rail pass)
- Introduce a headway managed line on Georgia Avenue and 7th Street to try to increase reliability
- Launch a mobile payment app in iOS (in production for Android)
- Conducting an electric bus pilot

Infrastructure Improvements

Poor reliability and declining bus speeds were the top complaints identified by transit riders among the agencies interviewed. Several of the participants felt that improving infrastructure was key to addressing these speed and reliability concerns. For WMATA, rider sensitivity to low bus speeds prompted the agency to work with the District Department of Transportation (DDOT) to build bus lanes, establish Transit Signal Priority (TSP) at key intersections, and install queue jumps to bypass traffic at intersections. MBTA has recently focused on building bus priority infrastructure to increase travel speeds and reliability. For a long time, the Silver Line was only bus priority line. In collaboration with municipalities, MBTA has been implementing TSP, bus lanes, and

queue jumps, and these efforts increased during the pandemic. In close consultation with SEPTA, the City of Philadelphia is working to develop pilot bus priority improvements throughout the city, having recently released a transit plan that outlines a vision for new bus priority corridors.

Improving Information

Missing or inaccurate information poses a barrier to retaining and attracting riders. LA Metro realized that the poor accuracy of real-time information contributed to the perception of reliability issues. The agency is now upgrading its on-board systems to provide vehicle location data that updates every 30-seconds as opposed to every three to five minutes.

SEPTA has recently worked to make their bus network more legible and easier to comprehend. The agency redesigned their network map to highlight the service frequency of routes. The map coincided with the reallocation of service to improve off-peak frequencies on some key transit routes.

Market Research Approaches by Transit Agencies

With the objective of identifying data collection strategies in the context of this research for NJ TRANSIT, agency representatives participating in the interviews were also asked about (a) the market research approaches they typically use, and (b) the types of approaches they utilized to collect data in the context of ridership decline. The interviewees mentioned diverse types of market research approaches, but they did not necessarily undertake them in the context of ridership decline. For example, many agencies have long conducted customer satisfaction surveys and tracked changing satisfaction rates. That helped the agencies formulate hypotheses about the causes of declining ridership. MARTA and LA Metro shared with the research team the results of focus groups and surveys that included current riders, infrequent riders, and non-riders. Both efforts illuminated differences in attitudes, level of comfort, and familiarity with transit among user groups. MBTA published a report in 2019 exploring causes of declining bus ridership that relied largely on ridership, fare card, and Census data, but did not include a survey component. The following are the typical market research approaches used by the agencies.

Data Mining of Transit Cards

Most agencies use a smart card or mobile app as the main form of fare media, and these cards provide useful trip data for analysis. Transit agencies can get in touch with users who have registered their fare media, providing an easily available base for survey recruitment. For example, MBTA, MARTA, and WMATA have pushed surveys to the email addresses of fare cardholders. A few agencies utilize the passive data generated by their fare cards to analyze trip making behavior. SEPTA, WMATA, and MBTA all cited the use of anonymized fare card data to estimate rider origin, destinations, and transfer

locations. Agencies noted that there is an inherit bias with any survey sample drawn exclusively from registered fare card users as certain demographic groups may be less likely to pay with or register their fare card.

Focus Groups

Many of the agencies interviewed use focus groups for open-ended feedback on a particular topic (e.g., solicit feedback on a new app or website, determine why customers may not feel safe on a particular route, etc.). The benefit of focus groups is that they are able to collect more detailed feedback from customers. For example, RTD has used focus groups to collect feedback on the public's perception of the agency, asking exploratory questions such as "if RTD was a grocery store, what store would it be and why?". The focus group recruitment process may involve the use of outside contractors, direct recruitment to customers by the agency, or recruitment from a pre-determined rider panel (See Rider Panels section below). MARTA mentioned that as a public agency, it is constrained in the type of incentives or benefits it can offer focus group participants (e.g., paying focus group members, providing food and refreshments, etc.).

Rider Panels

A rider panel is a pre-selected group of riders who agree to participate in future surveys. A handful of interviewees recruit and maintain a panel for surveys and focus groups. MBTA maintains a rider panel that it surveys once a month. Before the pandemic, the panel typically ranged from 1,000 to 2,000 participants but due to the pandemic limiting the agency's ability to recruit, the panel has declined to 600 participants. Participants are recruited through advertising in stations, on buses, and announcements.

Obtaining a representative sample of low-income and minority customers for bus ridership panels is challenging. WMATA weights results based on the full-system intercept surveys to account for this, but even these surveys may undercount certain groups. MBTA conducts more outreach to recruit for panels in areas where the response rate is expected to be lower and recognizes that the rider panel is skewed as it disproportionately includes frequent MBTA riders.

One of the benefits of having a stable panel over time is the ability to track changes in rider satisfaction and attitudes from a consistent group of people. MBTA has continued to survey its rider panel to gauge the public's comfort with riding transit during the pandemic and likelihood of returning to MBTA services.

Customer Satisfaction Surveys

Most agencies conduct some form of recurring customer satisfaction surveys. Recruitment methods vary but these surveys typically gauge attitudes on the satisfaction and comfort customers have with a service. Customer satisfaction surveys typically

require moderately sized samples, and therefore can be done at a greater frequency than origin-destination surveys.

Origin-Destination Surveys

Origin-destination (OD) surveys are typically the largest and most complex surveys conducted by agencies. All of the agencies interviewed either directly or through their metropolitan planning organization (MPO), conduct an intercept OD survey on a reoccurring basis. These surveys focus on collecting information on travel patterns and rider demographics. OD survey results provide a demographic profile of riders that agencies may use to weight the results of other survey efforts by factors like race, income, age, and language. OD survey data can be used for understanding how riders travel but cannot be used to determine the origins and destinations between which they would have liked to travel if service between those origins and destinations does not exist.

Conclusion

The interviews with the representatives of the eight transit agencies were insightful for the current study many reasons. They showed that the causes of ridership decline are many and no single cause can be attributed to the ridership decline for any specific agency. The potential causes of ridership decline described in the literature review, such as slowing speed, decrease in reliability, changing travel patterns due to suburbanization, increasing car ownership, proliferation of ridehailing, etc., were also mentioned in the interviews, but the interviews revealed that there is lack of conclusive evidence about the effect of many of these factors. Only in few cases, agencies were able to determine that the routes that experienced reduced travel time or worsening reliability lost riders more than other routes.

Perhaps the most insightful part of the interviews included the various types of measures the agencies undertook to address ridership decline. They showed that agencies often could not expand services to combat ridership decline because of resource constraints. Although two agencies did expand services, the efforts began due to policies adopted long before the decline. Besides, only one of those agencies experienced ridership gain. The interviews revealed that bus network redesign, reallocation of service, service improvements, infrastructure improvements, and improving information dissemination are far more common and they may be more effective.

The part of the interviews about market research showed that transit agencies basically continued to undertake practices that they have been undertaking since before ridership decline, but they began to utilize the findings in the context of ridership decline. It showed that the analysis of data through fare cards helped agencies to determine which routes experienced steeper ridership declines. New technologies also allowed agencies to determine which routes experienced greater travel time loss and reliability problems. Finally, the interviews did not reveal any specially designed targeted survey of riders or the general population to learn about the causes of ridership decline or potential remedies.

ONLINE SURVEY OF BUS RIDERS

The two major data collection efforts in this research were an online survey of NJ TRANIST bus riders and a telephone/mail survey of the general population of New Jersey. Prior to the online survey of bus riders, an online survey of past NJ TRANSIT riders (all modes) was conducted by compiling email addresses of riders who had not taken any NJ TRANSIT survey for a long time. The survey generated data from only 107 respondents. Because of the preliminary nature of the survey that was conducted primarily to inform the much larger online survey of bus riders, results from that survey are not included in this report.

This section summarizes the key findings from the online survey of bus riders that was conducted in September-October of 2021 by utilizing an email list of bus riders provided by NJ TRANSIT. It was anticipated that the email list would include both riders who currently ride the bus and riders who stopped riding the bus, allowing a comparison of the two groups and the identification of the reasons for the discontinuation of bus use by one group. At the outset of the research, the intent was to compare the current bus riders with all riders who stopped riding the bus, but because of the COVID-19 pandemic that began in March 2020, the riders who stopped riding the bus were divided into two groups: those who stopped because of COVID-19 and those who stopped for reasons other than COVID-19. The distinction of the riders who stopped because of COVID from those who stopped for other reasons was necessary to reduce confusion among the survey respondents, but that distinction also permitted a comparison of the characteristics of the two groups.

The survey questionnaire, developed in both English and Spanish, was approved by the Institutional Review Board of Rutgers University. The survey invitation was sent to 32,099 email addresses of bus riders obtained from NJ TRANSIT. However, 2,560 emails were invalid, reducing the number of recipients to 29,539. Out of those recipients, 3,287 took the survey, setting the response rate at 11.1%. Of the 3,241 respondents who answered the question on NJ TRANSIT bus riding history, 2,543 (78.4%) were still taking the bus at the time of the survey, 336 (10.4%) stopped because of COVID, and 362 (11.2%) stopped because of non-COVID reasons.

The objectives of the survey were to:

- Compare the demographic and socioeconomic characteristics of the riders who currently ride the bus with those who stopped riding the bus
- Identify the reasons for discontinuation of bus use by past riders
- Examine the consideration of factors or attributes associated with bus operations before the discontinuation of bus use
- Examine the consideration of factors or attributes associated with buses and bus stops before the discontinuation of bus use
- Identify transit improvements that would attract past riders back to bus

- Compare past and current riders' satisfaction with the bus and the perception of change in bus performance
- Examine the perceived reasons for riders' diversion from the bus to other modes
- Compare the bus-use patterns of the current riders with the riders who stopped riding the bus

Comparison of Demographic and Socioeconomic Characteristics

A comparison of the current bus riders with riders who stopped riding the bus is important to learn about the critical differences between them as well as to identify the bus riders who are more likely to discontinue riding the bus in the future. Such a comparison can also demonstrate how income, access to the automobile, employment, etc., are associated with the discontinuation of bus use, which adversely affects ridership. Most importantly, such a comparison can demonstrate which rider groups should be targeted for ridership retention.

The comparison of the respondents' gender revealed that the share of men is higher among those who stopped riding the bus compared to those who continued to ride the bus. For example, the share of men among the current riders is 36.0%, whereas their share among those who stopped because of non-COVID reasons was 40.4% and the share of those who stopped because of COVID was 42.3%. A similar comparison of age distribution between the three rider categories did not allow any generalization about younger or older age groups. For example, while the share of those below age 25 is the highest for the current riders, the share of those aged 25 to 34 is the lowest for the current riders. The proportions above age 55 are also similar across the three categories.

According to recent Census data, approximately 68% of New Jersey's population is White and 13% is Black or African American. In contrast, among the current bus riders in the survey data, only 33.3% are White, whereas 35.6% are Black or African Americans. It is not only that the proportion of White riders is substantially lower than the share of White population, but their share is also higher among those who stopped riding the bus because of non-COVID reasons. While the share of White riders who continue to ride the bus is 33.3% and the share of White riders who stopped because of COVID is 32.3%, the share of White riders who stopped for non-COVID reasons is 39.1%.

Figure 3 compares the household income of the three rider categories. It shows that the household income of the current riders is significantly lower than the riders who stopped because of COVID or non-COVID reasons. For example, their proportion is higher for the three income categories up to $50,000, but lower for all income categories beyond $75,000. It is worth noting that household income is higher for those who stopped because of COVID compared to those who stopped because of non-COVID reasons. That is likely the result of employment status; while 70.2% of those who stopped because of COVID are full-time workers, only 61.6% of the current riders and 62.5% of riders who stopped because of non-COVID reasons are full-time workers.

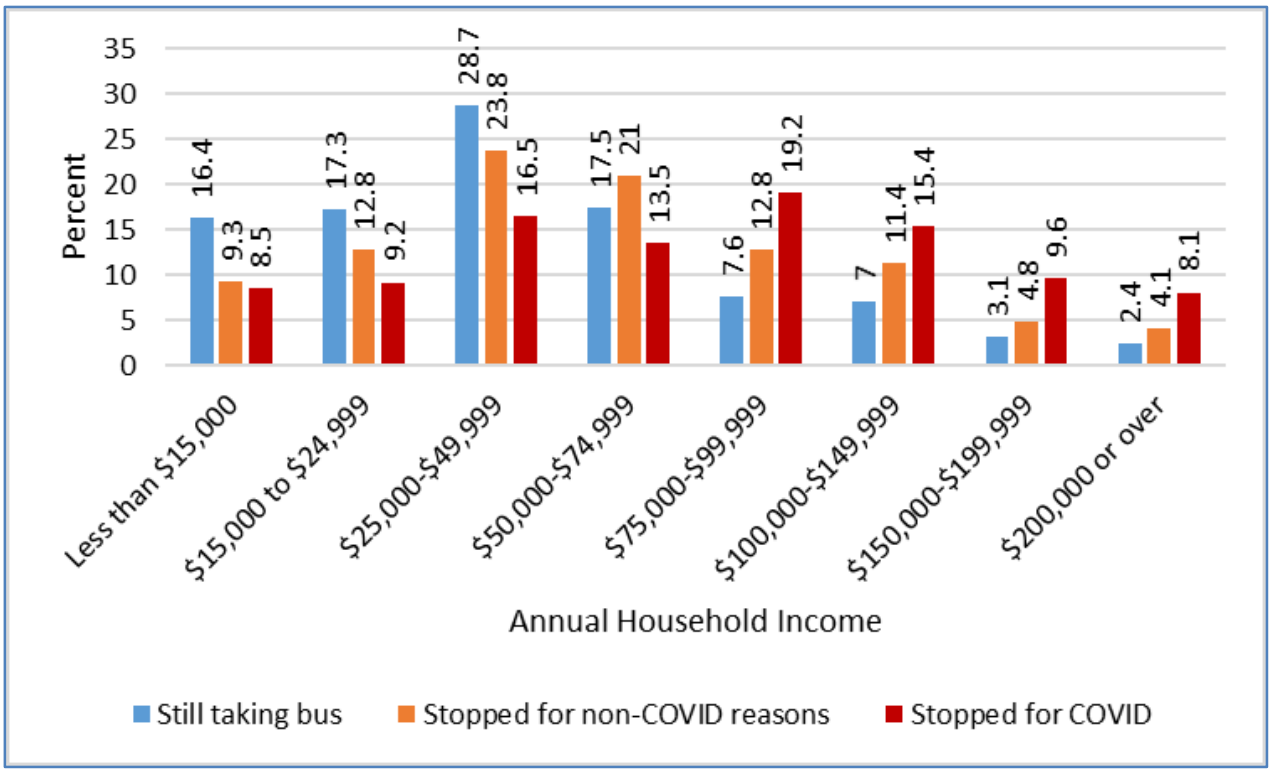


Figure 3. Household income of current bus riders, riders who stopped riding for COVID, and riders who stopped for other reasons

Consistent with household income and full-time employment, educational attainment is the lowest for the current riders and highest for the riders who stopped riding because of COVID. The proportion of respondents who did not go to college is 27.4%,18.9%, and 13.1% for current riders, riders who stopped for non-COVID reasons, and riders who stopped for COVID, respectively, whereas the proportion of respondents who had at least a bachelor's degree is 38.7%, 52.0%, and 62.5%. Thus, the riders who continued to ride the bus are of lowest standing in terms of income, employment, and education, whereas the riders who stopped because of COVID are of the highest standing. A reason for this could be that workers with full-time employment, higher income, and higher education received greater opportunities to work from home during the pandemic, which led to their discontinuation of bus use. Another reason could be that they moved or changed jobs in greater proportions.

A comparison between the three rider groups clearly indicated that riders with driver's licenses and greater access to household vehicles are more likely to stop riding the bus. Among the riders who continued to ride the bus, 50.3% did not have a driver's license, whereas among the riders who stopped taking the bus for COVID and non-COVID reasons, respectively, 21.0% and 21.8% did not have a license. Similar is the case with vehicles in household. While 58.5% of the current bus riders do not have a vehicle in

household, only 20.1% of the riders who stopped because of COVID and 24.7% of the riders who stopped for non-COVID reasons did not have a vehicle in household. The substantially higher proportion of riders with driver's licenses and the substantially lower proportion of riders without household vehicles among those who stopped riding the bus indicate that the greater ease of driving motivates riders to discontinue riding the bus.

Both access to cars and the possession of a driver's license have a direct association with the discontinuation of riding the bus is also evident from the responses to a question on the most frequently used travel mode for trips to work and school. It showed that only 3.7% of the current bus riders drive a car most often, whereas 51.8% of the riders who stopped for non-COVID reasons, and 28.6% of the riders who stopped for COVID drive a car most often for work and school trips.

The differences in characteristics of the survey respondents who have continued to ride the bus from the respondents who stopped riding for COVID or non-COVID reasons indicate that the current riders are a distinct group. That the respondents who stopped taking the bus have higher income, education, and access to cars indicates that many of the current riders could also stop riding the bus if their own economic conditions improved and they could have access to a car. The significantly greater access to household vehicles for those who stopped riding the bus provides evidence supporting the hypothesis formed during the interviews with transit officials about a direct association between automobile access and transit ridership.

The bus routes used by the three categories of bus riders were also compared to examine geographic variations. It revealed that, on average, the north Jersey local buses accounted for a greater share of current riders (58.8%) than riders who stopped for non-COVID reasons (52.5%) and riders who stopped for COVID (54.9%). The bus routes for the south Jersey region accounted for a smaller share of current bus riders and a larger share of riders who stopped for non-COVID reasons. The comparison thus seems to suggest that the likelihood of riders discontinuing bus use for non-COVID reasons was higher in south Jersey than north Jersey.

Reasons for Discontinuation of Bus Use

The literature review, as well as the interviews with transit agency representatives indicated that diverse types of factors could be responsible for the pre-COVID ridership decline. To identify the reasons in the specific context of NJ TRANSIT bus, the riders who stopped riding the bus for non-COVID reasons were asked a direct question about their reasons for discontinuation of bus use. The specific question was: "What were the reasons for you to stop using NJ TRANSIT bus?". Because a rider could have more than one reason, they could choose multiple responses. Although there were 362 respondents in the dataset who stopped riding the bus, because of the selection of multiple reasons by some respondents, there were a total of 520 responses. Table 2 shows the number of responses for each reason and percentages of responses as well as respondents. For

example, 126 respondents selected the choice “I began to drive a car,” which is 24.2% of all responses and 34.8% of all respondents who could have selected that choice.

Table 2 – Reasons for discontinuing bus use by riders who stopped riding for non-COVID reasons

Reasons	Respondents	Percent of responses	Percent of respondents
I began to drive a car	126	24.2	34.8
My home location changed	75	14.4	20.7
My work location changed	60	11.5	16.6
I stopped going to the places I used to go by bus	47	9.0	13.0
I began to work from home	44	8.5	12.2
I was no longer working	39	7.5	10.8
I began to use Uber or Lyft	38	7.3	10.5
I began to use commuter rail	14	2.7	3.9
I began to use light rail	14	2.7	3.9
I finished school or college	13	2.5	3.6
I began to use carpool or vanpool	9	1.7	2.5
Other reasons	41	7.9	11.3
Total		100.0	100.0
N		520	362

Table 2 shows that most respondents who stopped riding the bus for non-COVID reasons, view driving a car as the reason for their discontinuation of bus use. It is not only the top-ranked reason, but it was also selected by a significantly larger proportion of respondents than the second-most selected reason, which is change in home location. The fairly large number of respondents who selected change in home location, change in work location, and change in destinations shows that transit ridership at any given time is influenced by dynamic life circumstances of riders. While people or jobs moving out of the service area results in loss of ridership, people and jobs moving in also provides an opportunity to attract new riders. Thus, keeping track of the characteristics of the people moving in and out from the service area is important for retaining and attracting riders.

Among the travel modes included as an option in Table 2, ridehailing is second only to driving. The table also shows that diverting to other transit modes such as commuter rail and light rail is far less common than diverting to ridehailing services. While 34.8% selected driving and 10.5% respondents selected ridehailing, only 3.9% selected commuter rail and another 3.9% selected light rail.

To understand how life circumstances affected riders’ decision to stop taking the bus, the riders who stopped riding because of non-COVID reasons were asked if and how their life circumstances changed before the discontinuation of bus use. The proportion of responses received by each given option is presented in Figure 4. It shows that nothing changed for about half the riders, but among the those who experienced change, the

largest proportion reported change in financial situation. Such changes could include loss of income due to unemployment, but they could also include increases in income. Given the higher income of the respondents who stopped riding the bus compared to the riders who continue to ride the bus, it is likely that more of the 19% respondents who experienced change in financial situation had an increase in income rather than decrease in income.

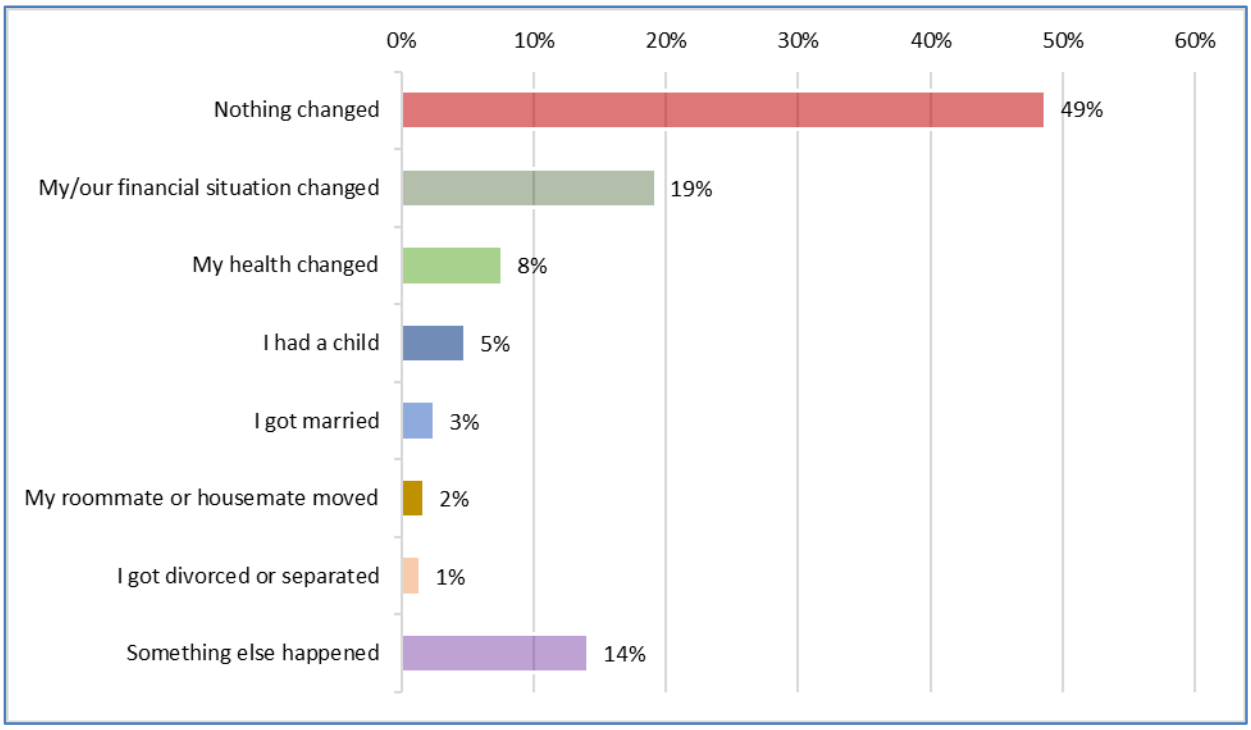


Figure 4. Change in life circumstances before discontinuation of bus use

To further investigate the effect of the automobile on discontinuation of bus use, the riders who stopped taking the bus for reasons other than COVID were also asked if they or someone else in their households purchased or leased a car before they stopped riding the bus. Their responses revealed that 33.6% purchased a car, 3.0% purchased and leased cars, and 4.2% leased a car (whereas the other 59.2% did not lease or purchase a car). Since comparable data were not collected from the riders who continue to ride the bus, a direct comparison cannot be made between the two groups. However, the fact that 58.5% of the current bus riders live in households without a car seems to indicate that their car purchasing/leasing propensity at any time would be much lower than those who stopped riding the bus. Thus, the fact that 41% of the respondents reporting purchasing or leasing a car before they stopped riding the bus is most likely a reflection of a direct association between access to a car and discontinuation of bus use.

The three most notable observations from the responses to questions on reasons for the discontinuation of bus use by the riders who stopped for non-COVID reasons are:

- Diverting to driving is seen as the reason by the largest proportion of respondents
- Home and job location change also contributed to discontinuation of bus use for a sizeable number of respondents
- Diversion to ridehailing services was second to driving and more significant than diversion to light rail or commuter rail
- Approximately 40% of the respondents either purchased or leased a car prior to discontinuing bus use

Consideration of Factors Associated with Bus Operations

To investigate what types of transit attributes may be associated with a rider's decision to discontinue bus use, the riders who stopped riding the bus for non-COVID reasons were asked two questions about the bus attributes they considered before discontinuation. In the first question, several options related to bus performance or operations were given to the respondents to select from. In the second question, the options included bus and bus-stop attributes that are not about bus operations. The responses to the first question are presented in Figure 5, whereas the responses to the second question are presented in Figure 6. Although the considerations in the two figures are not necessarily causes for discontinuation, they can be treated as factors associated with discontinuation.

Figure 5 shows the bus performance considerations for the riders before they stopped riding the bus. Because respondents could select multiple options, the percentages were calculated as proportions of responses rather than proportion of respondents. It shows that the top considerations were bus frequency (20%), bus access to trip origins and destinations (19%), bus trip duration (18%), and bus travel time reliability (14%). The factors such as parking, early morning service, and fares were less common responses, but service in the late evening hours received 10% of the responses. It is worth noting service in late evening/night hours received twice as many responses as service in the early morning hours (10% versus 5%).

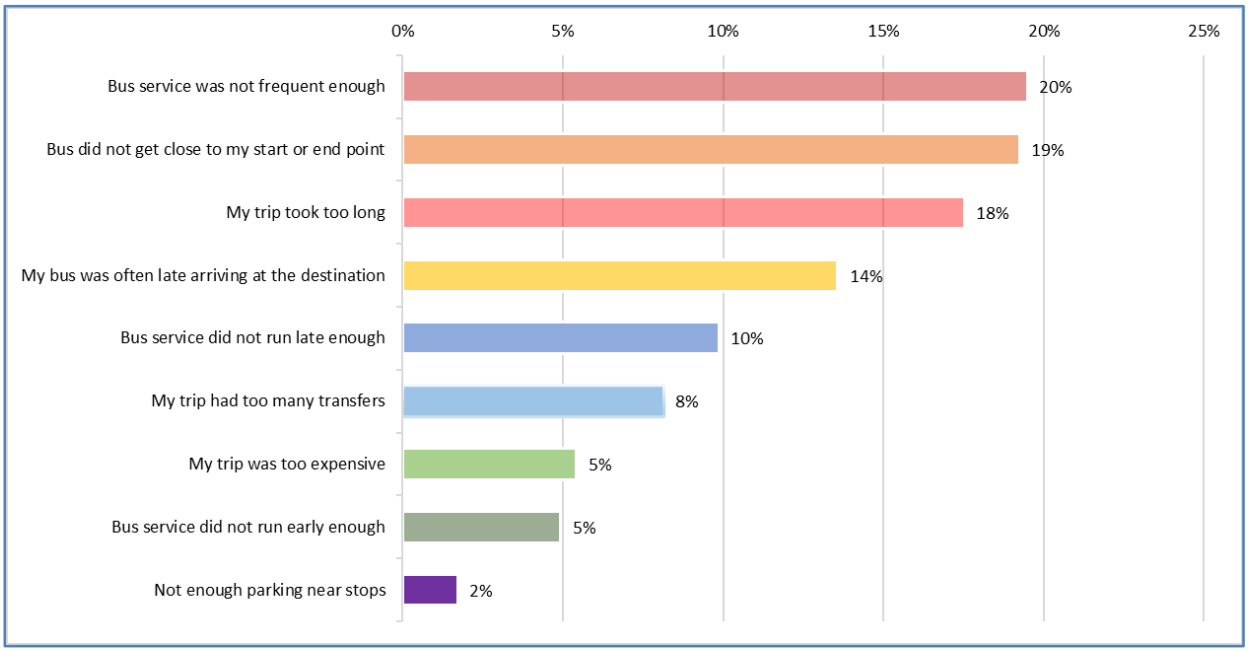


Figure 5. Bus performance considerations before discontinuing bus use

Figure 6 shows the riders' consideration of the attributes related to the bus and stops they used before discontinuation of bus use. Similar to Figure 5, the percentages are proportion of responses rather than proportion of respondents. It shows that crowding/difficulty getting seats was the most common consideration, which is consistent with bus frequency being the most common consideration in Figure 5. That is because greater frequency can ease crowding. Bus-stop amenities such as shelters and benches and cleanliness of bus stops each received almost one-fifth of the responses, but the share of responses for walking access to bus stops was only slightly lower.

Improvements to Draw Riders Back to Bus

To examine what types of improvements may be effective in drawing riders back to the bus, the riders who stopped riding for non-COVID reasons were given a list of potential improvements and asked if they would be drawn back to the bus with those improvements. Although their responses do not necessarily mean that they would return to use the bus, they provide insights about the attractiveness of specific improvements for riders who stopped riding.

One of the most notable findings from the responses to the question is that 80 or the 362 (i.e., 22.1%) riders who stopped riding the bus for non-COVID reasons indicated that none of they would not return to the bus for any of the improvements listed. Given the comprehensiveness of the list given to them, their response most likely means they do not anticipate returning to the bus under any circumstances.

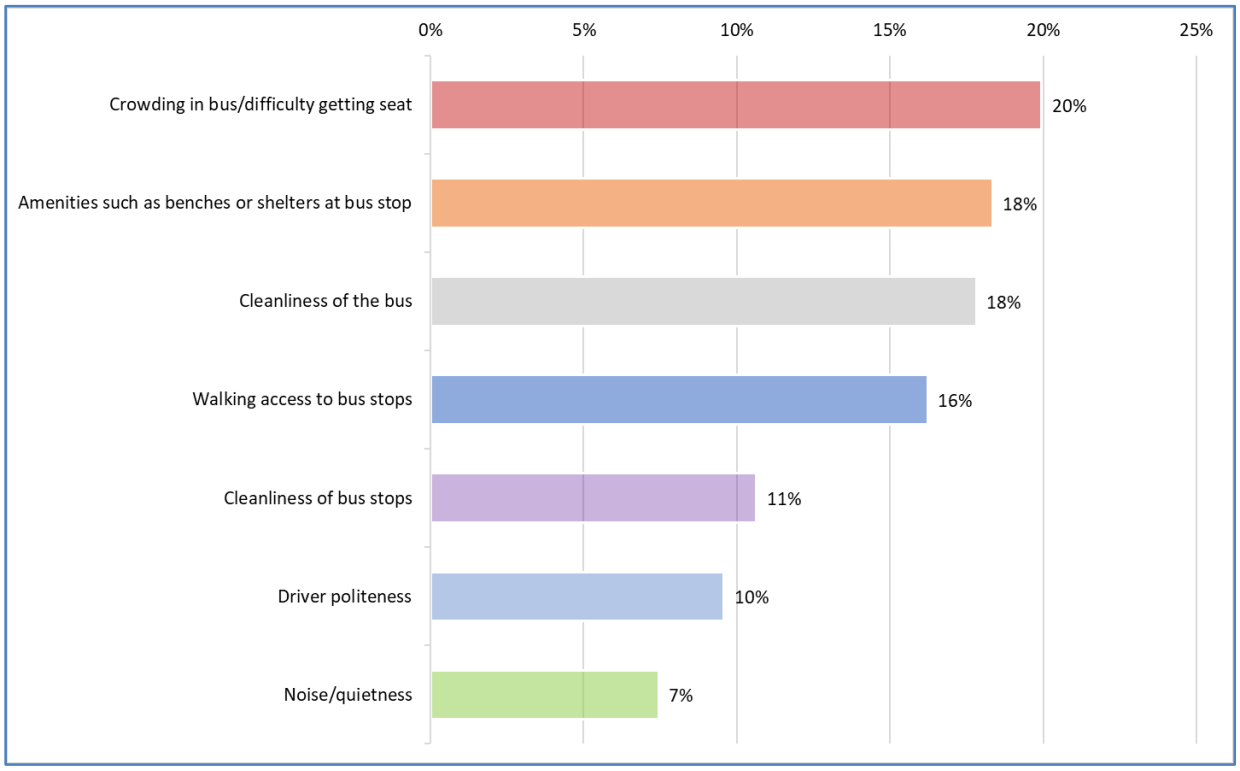


Figure 6. Bus and bus stop attributes considered before discontinuing bus use

The responses of the riders who selected one or more of the given improvements to draw them back to the bus are summarized in Figure 7. Similar to Figures 5 and 6, the percentages in the figure are proportions of responses rather than proportions of respondents. Consistent with Figure 5, which showed that most riders selected infrequent bus service as a consideration before discontinuing bus use, and Figure 6, which showed that crowding was the most common consideration, Figure 7 shows that more frequent buses received more responses than all other options (18%). These results clearly indicate that increase in frequency of buses in transit-rich areas should be a top priority for retaining current riders.

More direct buses to destinations is the second-most selected option at 13%, but the improved reliability (12%), improved bus-stop amenities (12%), faster travel time (11%), and improved proximity to bus stops from home (11%) were selected almost as often. Regarding more direct buses to destinations, it appears that expanding service to unserved areas would fulfill the objective, but that strategy would perhaps contradict the strategy to provide more service in transit-rich areas (especially in zero-sum situations). However, it may also be possible to provide more direct access to destinations within the current service area through network redesigns that consider potential destinations of bus riders. Overall, the responses indicate that, all the given improvements have merit, but

greater frequency of buses is the most desired improvement for riders who stopped riding the bus.

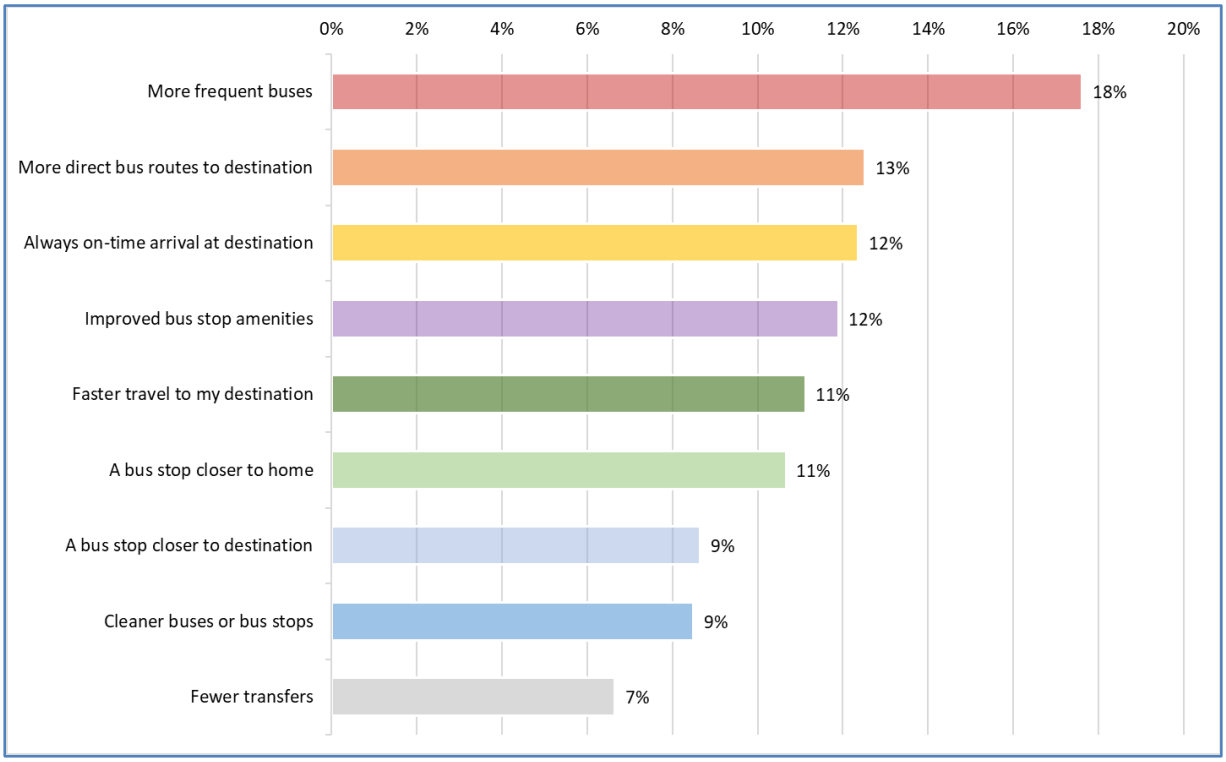


Figure 7. Selection of improvements to draw back riders who stopped riding for non-COVID reasons

Satisfaction with the Bus and the Perception of Service Quality Change

In another attempt to comprehend what might have caused riders to discontinue riding the bus, the current riders as well as the two groups of riders who stopped riding were asked about their satisfaction with the bus when they last rode the bus. A scale of 0 to 10 was provided in the survey to express satisfaction from the lowest to highest. The mean score for the current riders, the riders who stopped for non-COVID reasons, and the riders who stopped for COVID were 6.5, 6.4, and 5.9, indicating that those who stopped for COVID were less satisfied than the other two groups, whereas the other two groups were practically tied.

In addition to the question about satisfaction, the three groups of riders were also asked how the quality of the service changed between the time they used the bus for the first time and the time they used the bus for the last time. The expectation was that the two groups that stopped riding the bus would have a more negative perception of change compared to the riders who continued to ride the bus. The question on the perception of change pertained to (a) overall service quality, (b) bus service frequency, (c) crowding in

bus, and (d) service reliability in terms of arrival and departure time. The responses to the questions on each of these aspects are shown, respectively, in Figure 8, Figure 9, Figure 10, and Figure 11. Each figure shows the proportion of riders who perceived quality to have gotten better or worse. The proportion of riders who perceived the quality to have remained the same is not shown because it does not provide additional insights.

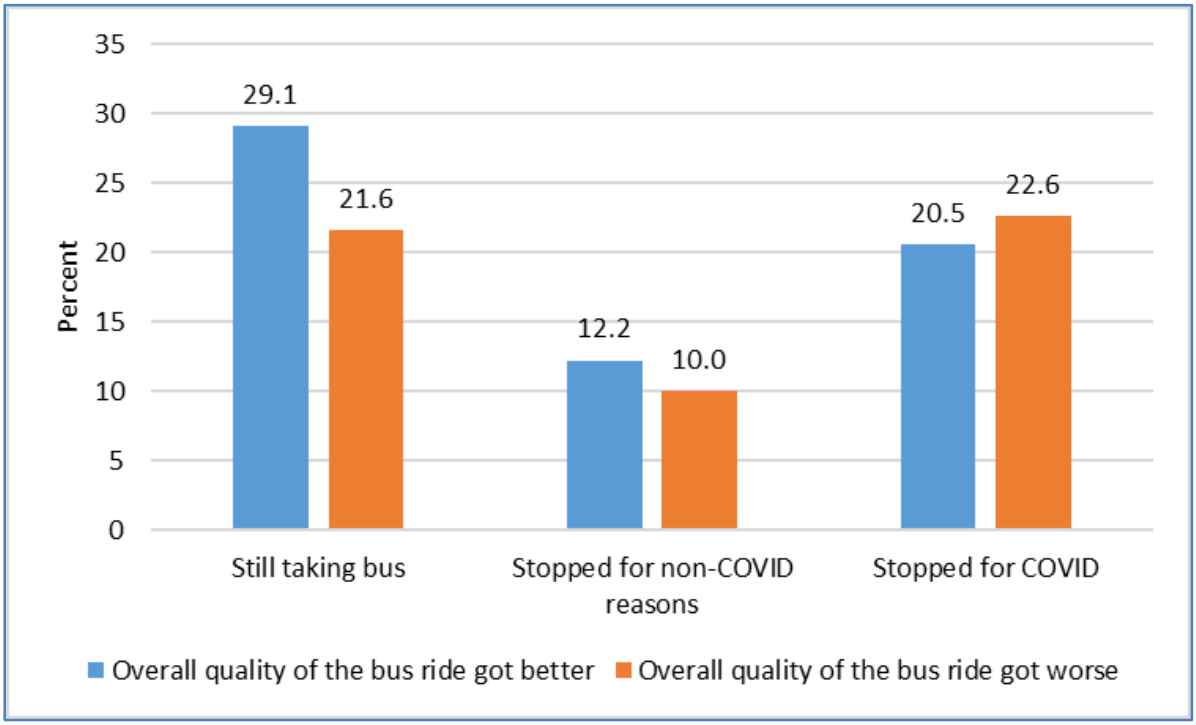


Figure 8. Perception of change of overall service quality

Figure 8 shows that the only group for which the proportion of riders who perceived the overall quality of service got worse is larger than the proportion of riders who perceived the overall quality of service got better are the riders who stopped riding because of COVID. This is consistent with their lower mean satisfaction score for the bus they used. Although the proportion of riders who perceived overall service quality got better is larger than the proportion of riders who perceived service quality got worse for the current riders as well as the riders who stopped for non-COVID reasons, the difference is more significant for the current riders than the other group. That is because the proportion perceiving service quality to have gotten better for current riders is 34.9% greater than the proportion perceiving service quality to have gotten worse for current riders, whereas for the other group the difference is only 21.9%. On the whole, in terms of overall service quality, the perception of change is most positive for the current riders and least positive for the riders who stopped because of COVID.

Figure 9 shows the perception of change of bus frequency, or interval between buses, between the first time and last time the riders used the bus. For all three categories of

riders, the proportion perceiving bus frequency to have gotten worse is significantly larger than the proportion of riders who perceived frequency to have gotten better. For the current bus riders, the riders who stopped because of non-COVID reasons, and the riders who stopped because of COVID, respectively, the proportion perceiving bus frequency to have gotten worse is 3.8 times, 7.9 times, and 5.1 times greater than the proportion perceiving frequency to have gotten better. These results are consistent with the results shown in Figure 5 and Figure 7, which indicated, respectively, that bus frequency is the most considered issue before riders stop riding, and improved bus frequency is their most desired improvement. However, it is important to bear in mind that the figure reflects perception of change of bus frequency rather than actual change in frequency.

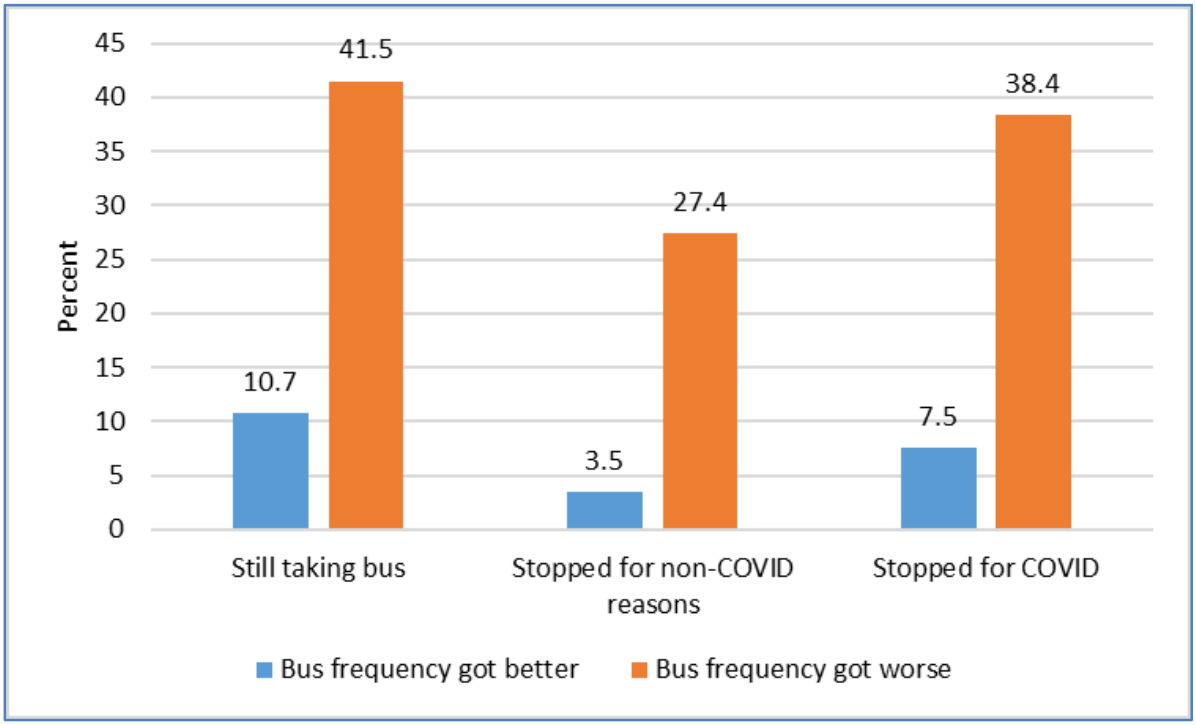


Figure 9. Perception of change of service frequency

Figure 10 compares the proportion of riders who perceived crowding in bus to have gotten better with the proportion of riders who perceived crowing to have gotten worse between the first time and last time the riders used the bus. It shows that the proportion perceiving crowding to have gotten better is more than twice as large among the current riders than the proportion perceiving crowding to have gotten worse (31.8% versus 14.6%), whereas the differences are minute for the other two rider groups. The reason for the current riders' perception of improved crowding in buses is most likely is the result of the COVID-19 pandemic, which reduced the number of riders in buses because of concerns about COVID and various precautionary mandates. Although the current riders might have begun to use the bus in ordinary times, when crowding might have been an issue, their last trip almost certainly was taken in the peri-COVID world in which ridership is lower.

The difference between those who believed that the chances of getting a seat improved versus those who believed that the chances got worse is not as large for the riders who stopped after COVID potentially because they stopped riding immediately after the pandemic began.

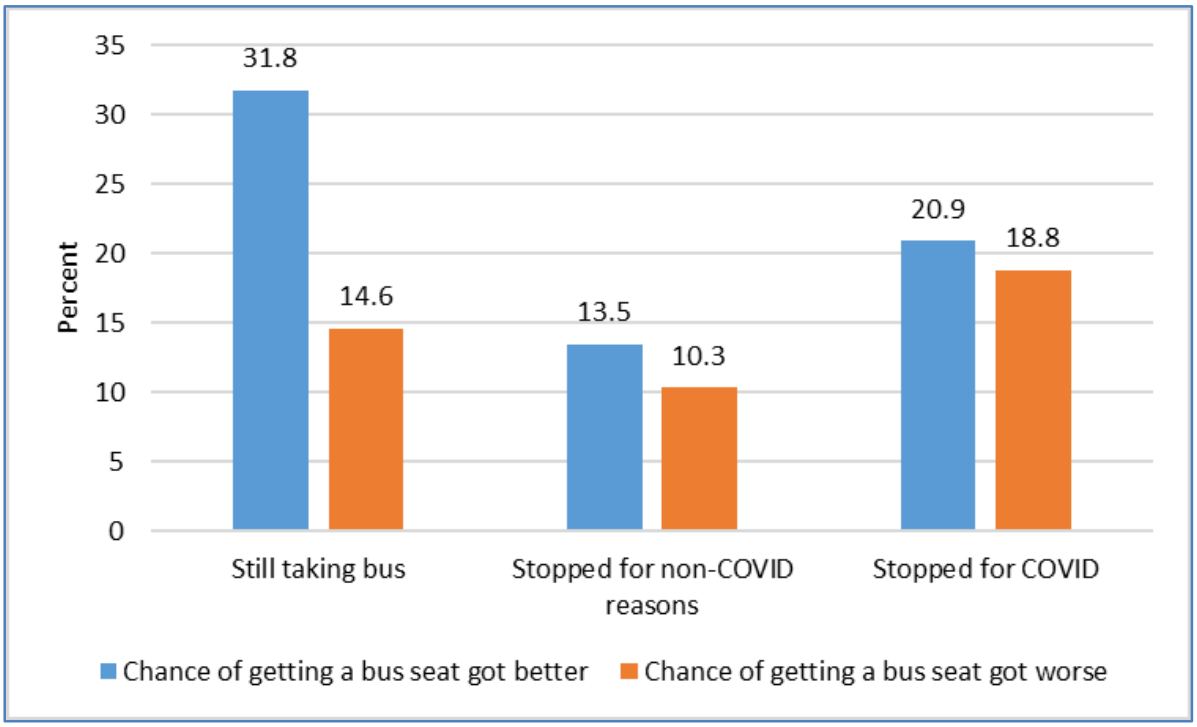


Figure 10. Perception of change of crowding

Figure 11 shows the perception of change of reliability of bus trips. Like bus frequency, it also shows that the proportion of riders perceiving a positive change is lower than the proportion perceiving a negative change. The perception of negative change of reliability is the strongest among the riders who stopped riding for non-COVID reasons, for the proportion of those riders who perceived reliability to have decreased over time is 12.6 percentage points greater (21.4% minus 8.8%) than the proportion of riders who perceived reliability to have improved. For the riders who stopped because of COVID and the riders who continued to ride the bus, respectively, the proportion that perceived reliability decreased is 8.6 and 4.4 percentage points greater than the proportion that perceived reliability improved.

If one were to develop bus service improvement strategies based on the results on the questions on perceived service quality change over time, the top priority should be on improving the frequency of buses. The second priority should be on improving reliability. The responses to the questions also indicate that inquiring about perceived change of overall quality of service may not generate meaningful responses because of the abstractness of overall service quality.

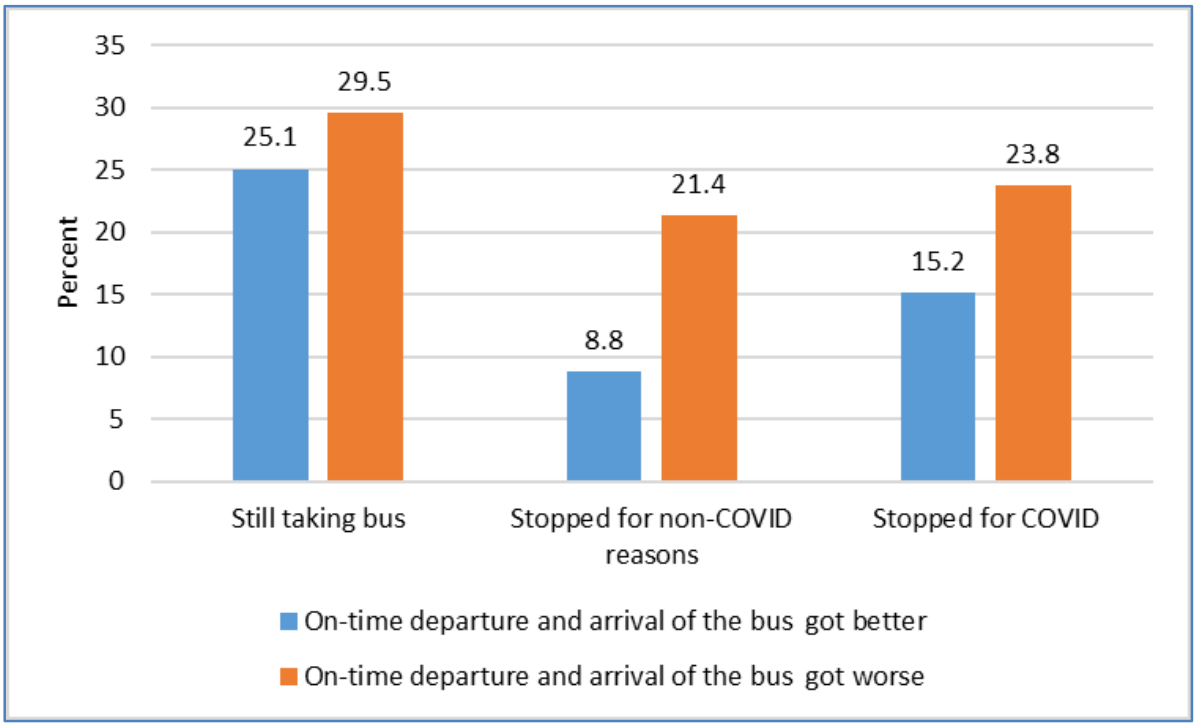


Figure 11. Perception of change of arrival and departure time reliability

Perception of Diversion to Other Modes

All survey respondents were asked a few hypothetical questions about potential diversion of bus riders to other travel modes. In each question, a particular travel mode was mentioned, and the respondents were asked if people were taking the bus less often because of a diversion to that mode for a particular reason. An example is whether people are making fewer bus trips because of lower gas prices. Another example is whether people are now taking the bus less often because of travel time advantage of Uber and Lyft.

The responses to these questions did not vary substantially among the three categories of riders. A significantly larger proportion of all three categories of riders agreed, rather than disagreeing, to the diversion of riders from the bus to driving and ridehailing. However, for both modes, the respondents perceived the diversion occurred because of a travel time advantage of the modes rather than a travel cost advantage. For the question asking if people are diverting to the car because of a decreasing cost of owning and leasing a car, the proportions agreeing and disagreeing were not very different. For the question asking if people are diverting to the car because of a decrease in gas price, more people disagreed than agreed. For the question on diversion to light rail and commuter rail also, more respondents agreed than disagreed, but the proportion agreeing was much smaller than that for diversion to ridehailing and driving. Overall, the respondents clearly

acknowledged the travel time advantage of driving and ridehailing but were not clear about their cost advantage.

Comparison of Bus Use Patterns

To examine how the current bus-use pattern of the current bus riders is different from the past bus-use pattern of the riders who stopped riding, questions were asked to each group about bus trip purpose, frequency of bus trips, time of travel, type of tickets used, and access/egress mode to bus stops. The question on trip purpose revealed that the current riders make less frequent work trips (21.6%) compared to riders who stopped for non-COVID reasons (24.5%) and the riders who stopped because of COVID (32.3%). In contrast, the current riders make a greater proportion of trips for shopping, errands, and healthcare purpose.

Regarding frequency of making bus trips, the proportion of riders who make trips seven days a week is larger for current bus riders (16.0%) compared to the riders who stopped for non-COVID reasons (10.0%) and the riders who stopped for COVID (5.6%), whereas the proportion of the first group making trips five days a week is lower (28.8%) compared to the other two groups (36.1% and 38.2% respectively). These results seem to reflect a greater dependence on the bus for current riders compared to the two other groups. Regarding time of travel by bus, the current riders are discernably different because of a larger share of trips between 9 AM and 3 PM (24.1%) compared to the riders who stopped for non-COVID reasons (19.6%) and the riders who stopped for COVID (17.5%). A larger share of walk trips for access and egress to bus stops also makes the current riders different form the other two groups. While 88.2% of the current riders mentioned walking to and from stops, 83% of the riders who stopped for non-COVID reasons and 70.4% of the riders who stopped for COVID mentioning walking. The types of tickets used were not substantially different for the three groups.

Conclusion

The online survey of bus riders, in which more than 3,000 past and current riders participated, provided useful insights regarding the reasons for riders' discontinuation of bus use, differences between current and past riders, and desired service improvements. The analysis of reasons for discontinuation of bus use, as well as the purchasing and leasing of automobiles clearly indicated that access to the car was an important factor for discontinuation of bus use for many. The analysis of variables such as number of vehicles in household, driver's license possession, and travel modes commonly used for work/school trips clearly indicated that the riders who stopped riding the bus had greater opportunities to divert from the bus to the automobile.

The comparison of household income, employment, and education also revealed that the current bus riders are socioeconomically disadvantaged compared to the riders who stopped riding. The differences in income and car ownership indicate that many current

riders may be riding the bus out of necessity rather than choice. In other words, the current riders are dependent on the bus, whereas the riders who stopped riding the bus had other options to travel.

Although acquisition of a car, driving, moving, changing job location, etc., were cited by many riders who stopped riding the bus, those responses cannot be construed in a way that makes the reasons for discontinuing bus use entirely external to bus service quality. Responses to several questions revealed that the riders who stopped riding considered certain negative aspects of the bus before they stopped. When asked about desired improvements also, riders mentioned several bus service attributes. Responses to multiple questions revealed that bus frequency is the greatest concern for bus riders, followed by travel time reliability. The respondents also seem to recognize that both driving and ridehailing have a clear travel time advantage over the bus.

A SURVEY OF NEW JERSEY RESIDENTS

Another major component of this research was a survey of the general population of New Jersey. While the online survey of bus riders described in the previous section allowed the collection of data from riders who currently use the bus and the riders who stopped riding the bus because of COVID or non-COVID reasons, the respondents of that survey did not include residents of New Jersey who never used the bus. The data from the past and current riders can help to develop strategies to retain bus riders, but they do not help to understand what needs to be done to attract new riders to the bus.

The general population survey of New Jersey residents was primarily conducted by random-digit-dialing telephone interviews and complemented by a mail survey of residents living in selected disadvantaged communities where response rate for telephone surveys is often low. The two surveys were conducted concurrently in November-December 2021. A total of 1,313 respondents took the telephone survey, while 130 respondents returned the mail survey, resulting in a combined dataset with 1,443 observations. The surveys could be taken by New Jersey residents aged 18 and over only. The sampling bias of the telephone survey data was corrected by developing a weight based on comparison of the survey data with New Jersey population in terms of sex, age, education, region, race/ethnicity, and phone use. The adjusted margin of error for the survey of 1,313 respondents was ± 3.0 percentage points. The sampling bias for the mail survey needed to be corrected only for age and gender as the sample proportions were similar to the population proportions for the socioeconomic variables.

Figure 12 shows the zip codes where the telephone survey and mail survey respondents live. Areas colored purple on the map are zip codes with respondents from both surveys. Since most of the zip codes with mail survey respondents also had telephone survey respondents there are very few zip codes with only mail surveys (shown in red). The map shows that the telephone survey respondents live throughout New Jersey, whereas the mail survey respondents live in small pockets that are located within urban centers. The

telephone survey and the mail survey questions were virtually identical, but prompts were added to certain telephone survey questions for clarity. Both questionnaires were approved by the Institutional Review Board of Rutgers University.

Similar to the online survey of bus riders, the original intent of the general population survey was to treat the riders who stopped riding the bus as one group. However, because of the COVID-19 pandemic that began after the project's inception, the riders who stopped riding the bus were divided into two groups: those who stopped before COVID began and those who stopped after COVID. Among the 1,443 survey respondents, 1,334 provided the information on their history of using NJ TRANSIT bus. Based on that information, 579 respondents (43.4%) never used the bus, 245 (18.4%) currently use the bus, 149 (11.2%) stopped riding the bus after COVID began, and 360 (27.0%) stopped riding the bus before COVID began.[2]

The primary objective of the general population survey was to understand the needs of the potential riders who have not used the bus in the past and compare them to the needs of the other groups. The specific objectives were to

- Compare the past and current bus riders with people who never used the bus regarding socioeconomic characteristics and proximity to bus stop
- Examine who among the bus non-users considered using the bus
- Examine the purposes for which the bus non-users would travel by bus
- Examine the places between which the bus non-users would like to travel by bus
- Examine the reasons for which bus non-users refrain from using the bus, including their perceptions about the bus and barriers to using the bus
- Examine the perceived competitiveness of the bus with the most-often used travel mode of bus non-users
- Identify bus service improvements that would attract bus non-users to the bus
- Compare the bus use patterns of the current bus riders with the riders who stopped riding before COVID and after COVID

[2] All respondents defined as "those who never used the bus" selected the survey option "I have never ridden NJ TRANSIT local buses," but may include some who used the bus long time ago.

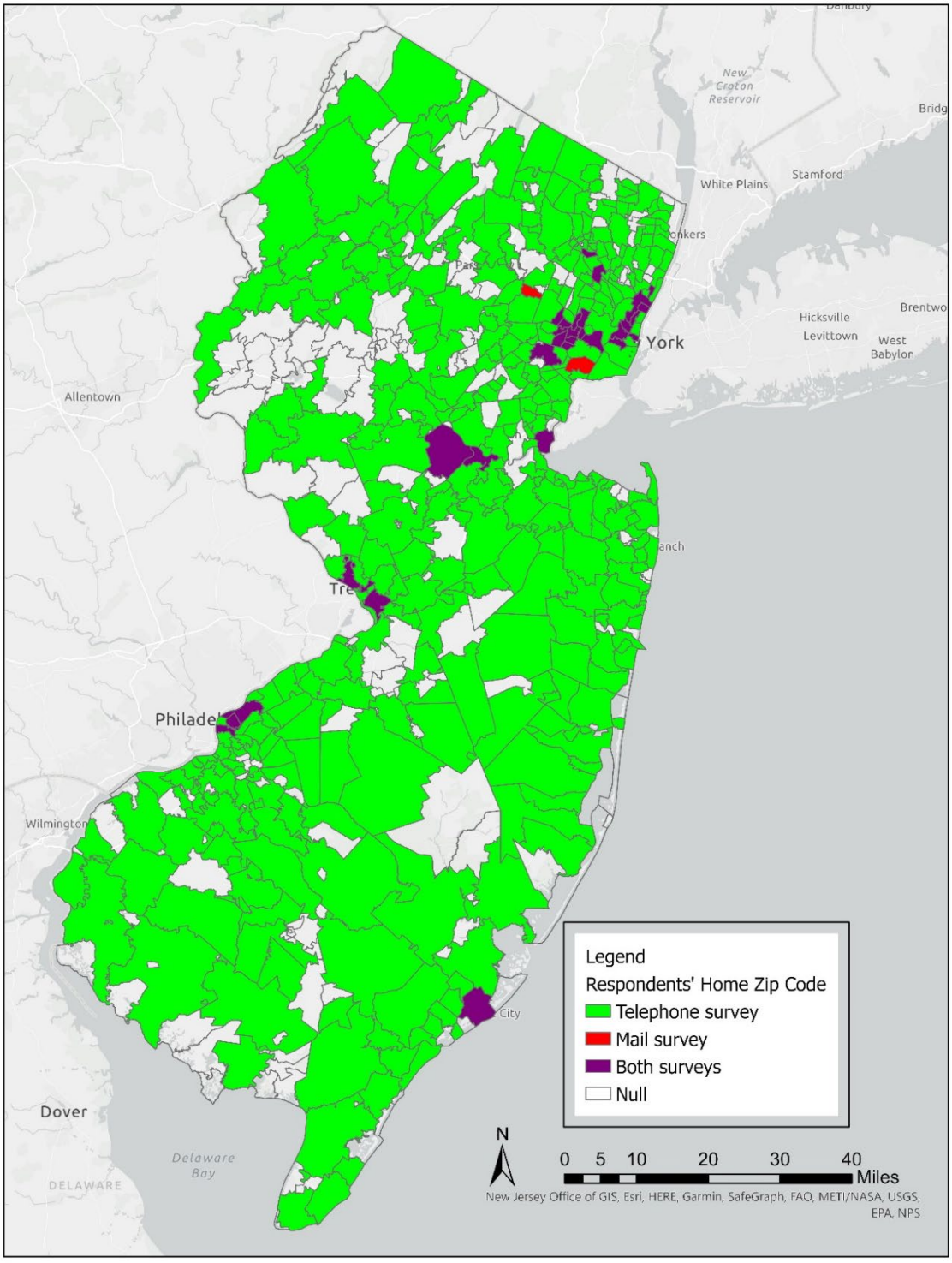


Figure 12. Residence zip codes of telephone and mail survey respondents

Differences in Demographic and Socioeconomic Characteristics

A comparison of demographic and socioeconomic characteristics of people who never used the bus with those who currently use the bus can provide insights about attracting bus non-users to the bus. On the other hand, a comparison of current bus riders with the riders who stopped riding the bus can provide insights about retaining riders.

A comparison of the gender distribution of the four respondent categories did not show substantial differences between the proportions of males and females, except that the proportion of females was slightly larger than the other three categories for the riders who stopped riding after COVID. A comparison of the age distributions revealed that the share of young people (age 18-34) is the lowest among the respondents who never used the bus (21.1%), followed respectively by those who stopped before COVID (27.4%), those who currently use the bus (35.5%), and those who stopped after COVID (43.0%). On the other hand, the share of older respondents (age 62+) is the highest among those who never used the bus (32.8%), followed respectively by those who stopped before COVID (31.3%), those who stopped after COVID (17.4%), and those who continued to ride the bus (16.3%). The lower proportion of young respondents among those who never used the bus and the higher proportion of young respondents among those who currently use the bus may suggest that bus ridership will increase during the next two or three decades as the currently young people reach middle age. However, that will depend on (a) whether they will continue to use the bus when they age, and (b) whether the people reaching age 18-34 then will use the bus at a higher rate like the current people in that age cohort. Based on the age distribution of the four categories of respondents, strategies to retain the current young bus riders and continuing to attract new young riders appear to be appropriate.

A comparison of the respondents' race showed that 76.6% of the respondents who never used the bus are White, while all other races combined account for the remaining 23.4%. In contrast, White respondents constitute 39.1% of those who currently use the bus, whereas respondents of all other races combined constitute 60.9%. It is notable that among those who stopped using the bus before COVID, the proportion of White respondents is quite high (60.2%), indicating once again that those who stopped using the bus before COVID are more similar to those who never used the bus than the current bus users and those who stopped after COVID.

The share of Black or African American respondents is disproportionately high among current bus riders (29.8%) and disproportionately low among those who never used the bus (only 7.5%). Their share is significantly higher among those who stopped before COVID (17.5%) and after COVID (20.3%) than those who never used the bus. The share of Hispanics is also the highest among the current riders (30.0%), followed respectively by those who stopped after COVID (23.8%), those who stopped before COVID (18.4%), and those who never used the bus (14.0%). Thus, in terms of race and ethnicity, those who never used the bus are clearly distinct from the other three groups.

The four categories of respondents are shown by number of vehicles in household in Figure 13. It shows that only 4.9% of the respondents who never used the bus belong to households without any vehicle, whereas 42.4% of the respondents who currently use the bus belong to such households. It is not only in terms of the proportion of households without vehicles that makes those who never used the bus different from those use the bus because the number of vehicles in a household is also larger among those who never used the bus. For example, almost one-third of the respondents who never used the bus had three or more vehicles in a household (31.6%), whereas only 6.1% of the respondents who currently ride the bus belong to such households. Once again, the data show that the respondents who stopped using the bus before COVID are far more similar to the respondents who never used the bus than the other two respondent categories.

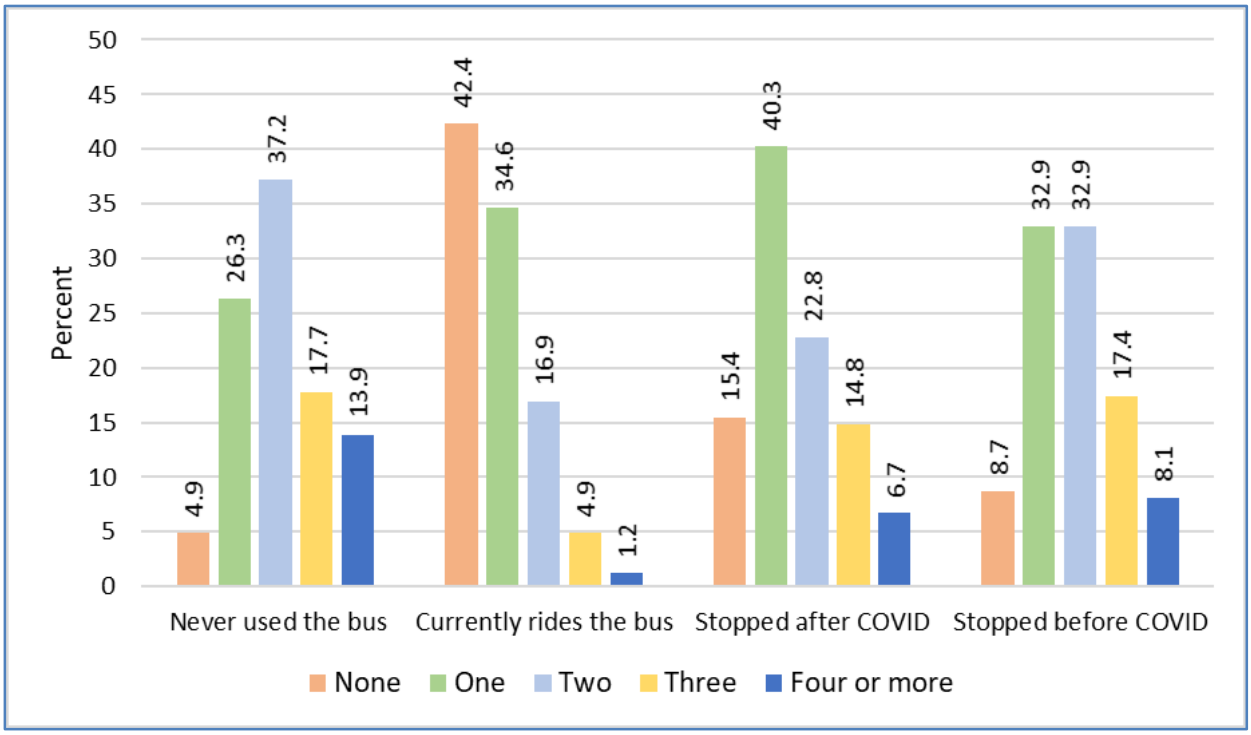


Figure 13. Number of vehicles in household

Household income is another variable that distinguishes those who never used the bus from the other three groups, but it distinguishes that group the most from those who currently use the bus. That is because those who never used the bus have the highest level of income and those who currently use the bus have the lowest level of income. Figure 14 shows that the share of respondents with less than $50,000 income among those who never used the bus is 19.1% whereas respondents with that level of income constitute 55.9% of those who currently use the bus. When the share of respondents with income $100,000 or more is 39.9% among those who never used the bus, only 17.6% of those who currently use the bus have that level of income. The household income of

those who stopped taking the bus before COVID is more similar to those who stopped after COVID than those who never used the bus. By comparing Figure 13 and Figure 14, one can infer that the income distribution and vehicle distribution of the four categories of riders correspond very well: the categories that have higher income also have more vehicles in household, whereas the categories that have lower income also have fewer vehicles in household.

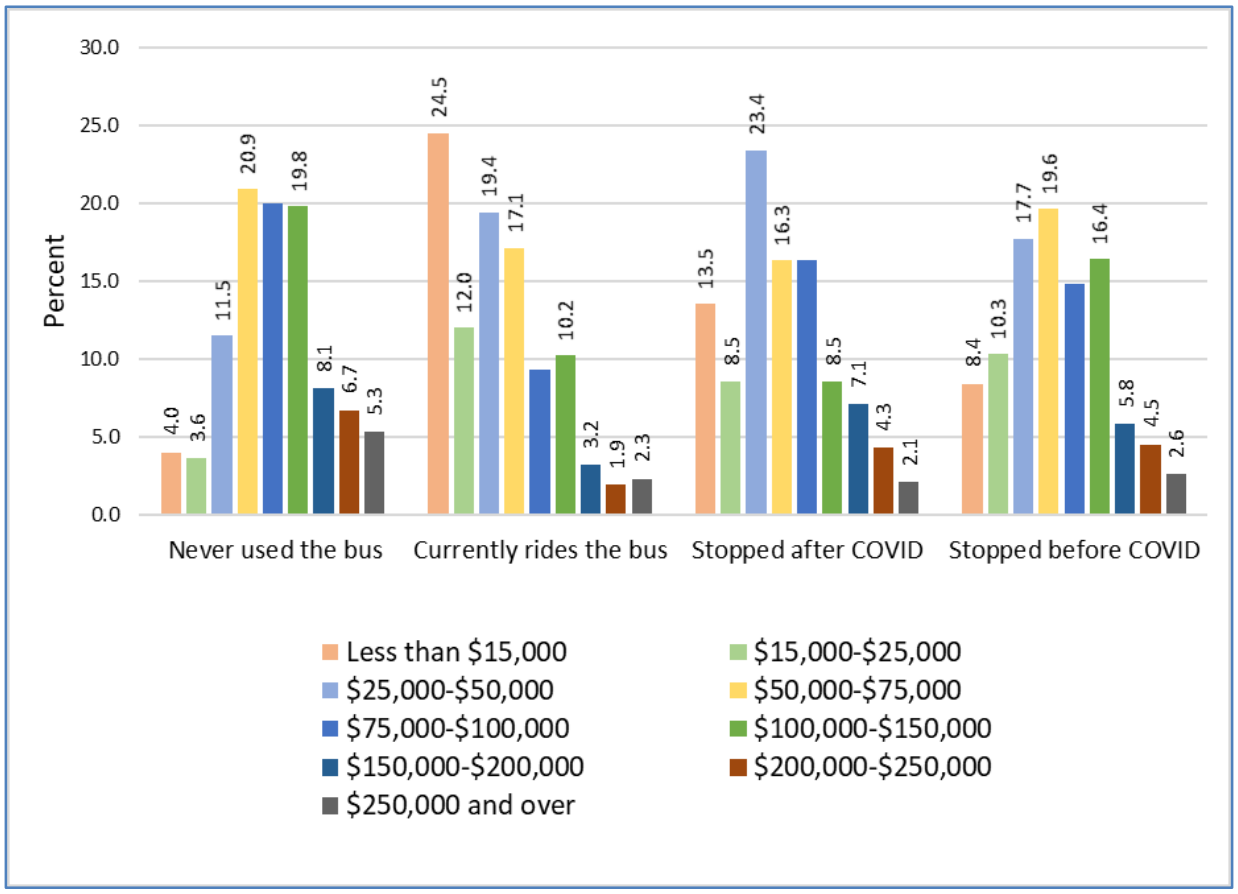


Figure 14. Annual household income

An analysis of employment status showed that the share of full-time workers is similar across the four respondent categories, ranging between 45.7% among the current bus riders and 50.3% among those who never used the bus. The share of part-time workers is significantly higher among those who stopped after COVID (19.2%) compared to around 10% for the other three categories, but that is to be expected because part-time workers are more likely to quit jobs because of the pandemic than full-time workers. Consistent with the higher proportion of respondents in older age groups among those who never used the bus, the share of retirees is also significantly higher for that category or respondents.

A comparison between the categories of riders showed that educational attainment is the highest among those who never used the bus and lowest among those who currently use the bus. For example, when the share of respondents who did not report education beyond high school is only 25.5% among those who never used the bus, the share is 42.0% among the current bus riders. Furthermore, the share of respondents who acquired at least a 4-year degree is 49.6% among those who never used the bus, whereas the share is only 30.8% among those who currently use the bus.

Proximity to Bus Stops

The analysis of the demographic and socioeconomic characteristics of the four categories of respondents in the previous section showed that substantial differences exist between the categories and the differences are the starkest between the riders who currently ride the bus and the people who never rode the bus. While the current riders are the most socioeconomically disadvantaged, those who never rode the bus are the most advantaged. If socioeconomic attributes influence who uses the bus and who does not, convincing those who never used the bus to ride the bus would be the hardest. However, there are other factors that could also potentially influence a person's decision to use the bus. The most notable among them is perhaps proximity to the bus network. If bus service is not available nearby, a person's likelihood of using the bus can be expected to be low because traveling to the nearest bus stop may require another vehicular trip. If a bus stop is not nearby, people may not even consider the bus as a travel option.

To illustrate that many bus non-users live far from the bus network, two maps are presented in Figure 15 and Figure 16. The first shows the zip codes of the survey respondents categorized by their bus riding history. Because respondents from different categories could live in the same zip code, many of the zip codes in that map are identified as overlapped categories. Yet, the map also shows many zip codes where only one category of respondent live. It is evident from the perusal of those zip codes that many respondents who never used the bus live in the northwestern and southern parts of the state, where bus service is rare or non-existent.

Because of the large number of overlapping zip codes in Figure 15, another map is presented in Figure 16 that classifies the overlapping zip codes to the four categories of respondents by considering the most dominant category. In that map, the color of the zip code represents the category with the largest number of respondents. For example, if the number of respondents who never rode the bus is four and the number of respondents from each of the other three categories is less than four, the color represents those who never used the bus. This map shows that many zip codes where those who never used the bus are dominant are located far from the bus network, whereas many zip codes where the current bus riders are dominant are in the transit-rich northeastern part of the state.

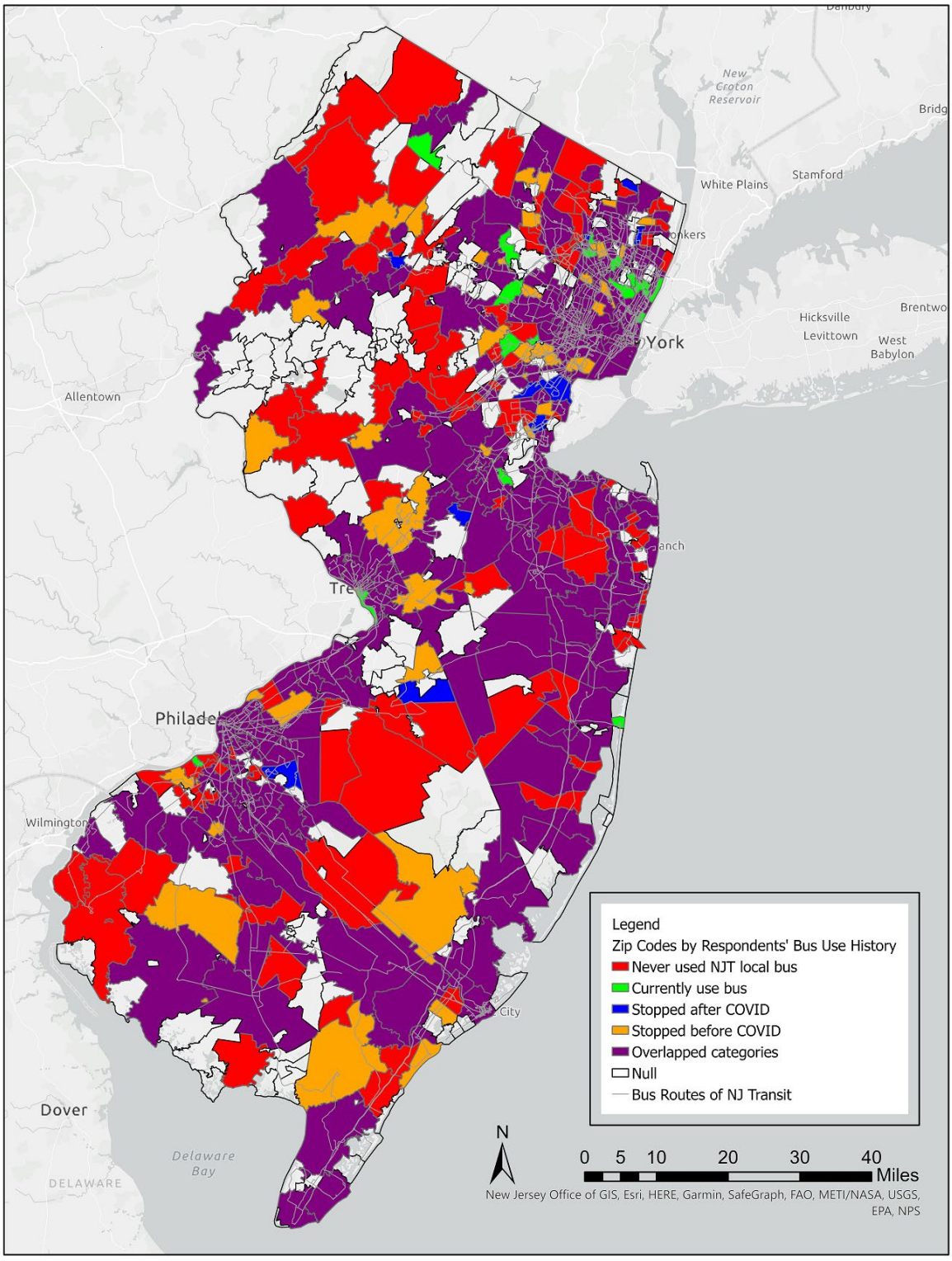


Figure 15. Zip codes categorized by respondents' bus use history

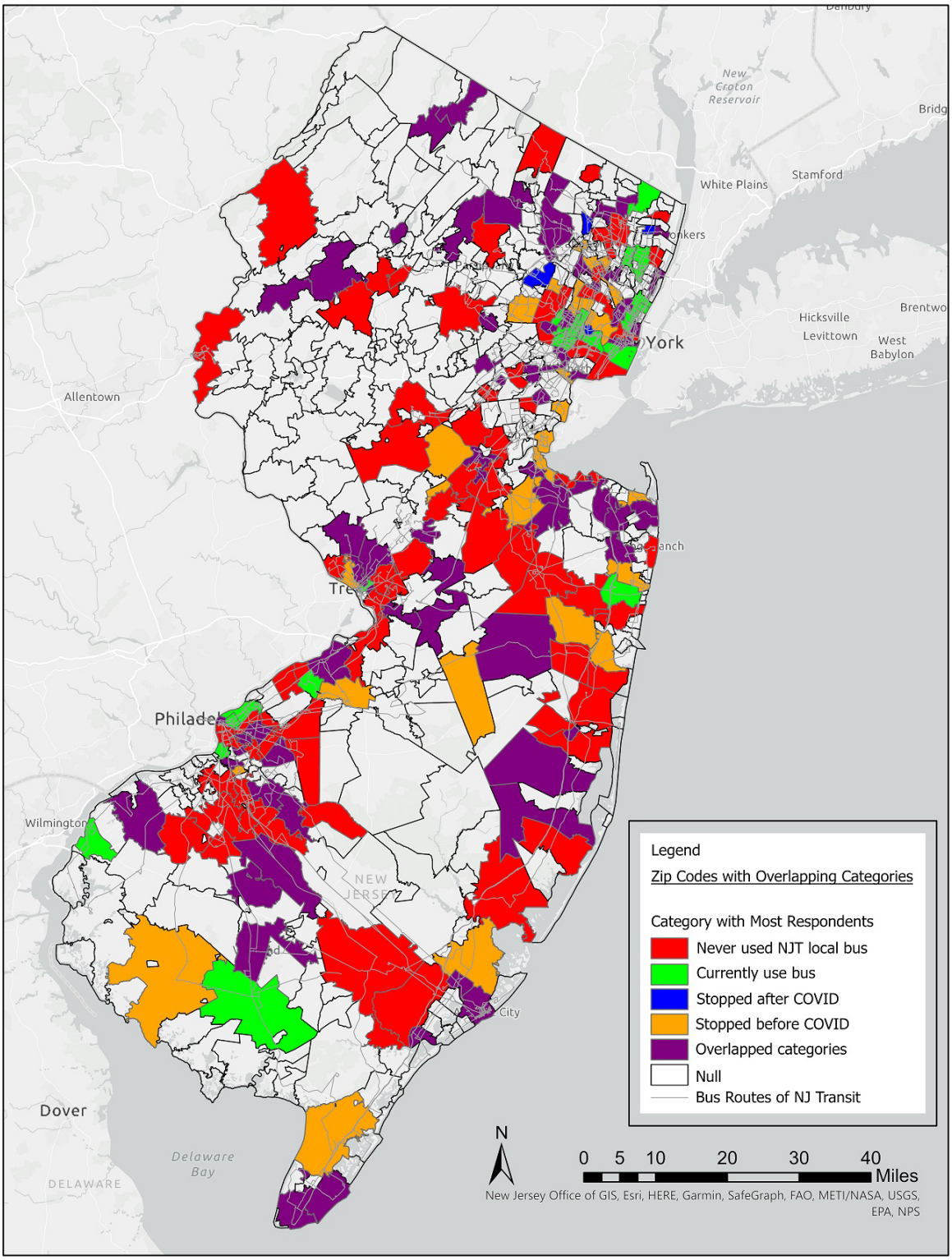


Figure 16. Overlapping zip codes classified by dominant respondent category

Although the maps in Figure 15 and Figure 16 provide an impression at the macro level about the proximity to bus stops for the four categories of respondents, they are not sufficient to fully explain the effect of proximity to bus stops on the propensity to use the bus. For that purpose, responses to a survey question were analyzed and additional GIS analysis was undertaken.

To compare the proximity to nearest bus stops for the four respondent categories, the survey respondents were asked how long it took to walk from their homes to the nearest NJ TRANSIT bus stop. The results are summarized in Figure 17. The figure does not include those who did not know where the bus stop was or how long it took to walk. When a comparison is made between the groups regarding walking time less than 10 minutes, which is often used as typical walking time for transit users, the share is the highest for those who currently ride the bus (76.9%) and lowest for those who never used the bus (43.8%). When a comparison is made for walking time less than 15 minutes, the share for the first group is 90.5%, whereas the share of the second group is 58.3%. The stated walk times to the nearest bus stops for those who stopped before and after COVID are close and they fall between the current bus riders and those who never used the bus. Thus, proximity to bus stops is clearly a factor that makes a difference between who takes the bus and who does not.

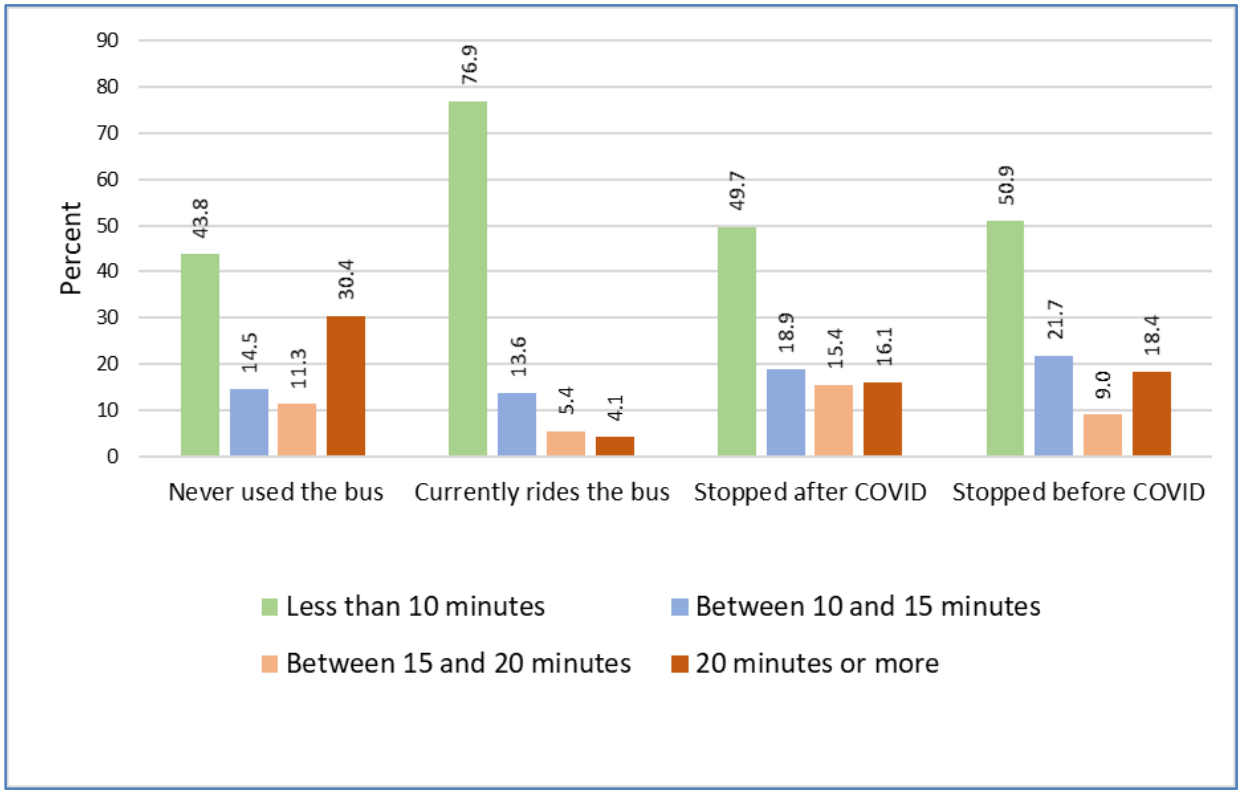


Figure 17. Walk time from home to the nearest bus stop

To be able to objectively measure the distance between home and the nearest NJ TRANSIT bus stop, a question was included in the survey to name a street intersection near home. About half of the respondents provided that information. Those intersections were geocoded and the street or network distances between the intersection and the nearest bus stops were calculated by using the ArcGIS network analyst. Figure 18 shows the distributions of the four categories of respondents by distance to the nearest bus stop. Consistent with Figure 17, it shows that the distance to the nearest bus stops is the lowest for the current bus riders, whereas the distance is the highest for those who never used the bus. While approximately 95% of the current riders live within one mile of the nearest bus stops, less than 70% of those who never used the bus live within that distance.

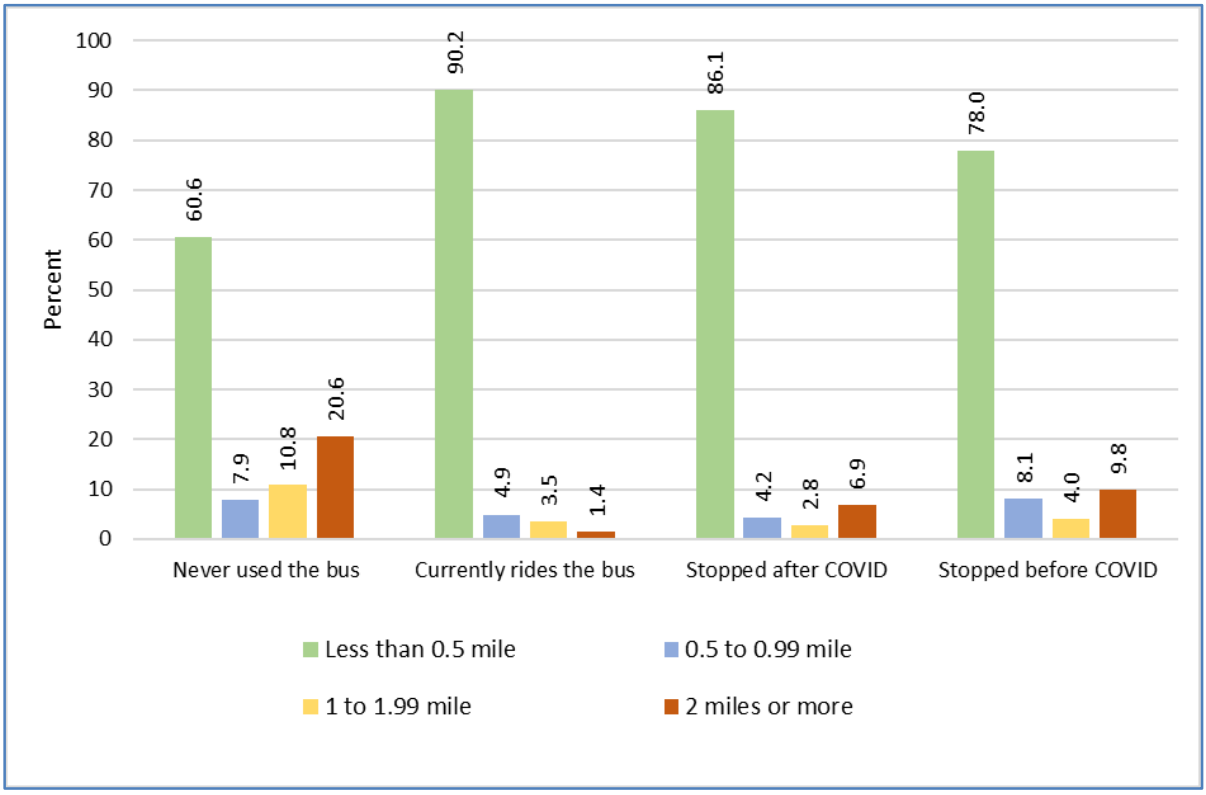


Figure 18. Walk time from home to the nearest bus stop

A third variable was analyzed to examine the proximity of the survey respondents to bus stops. That variable was the number of NJ TRANSIT bus stops within a half mile of the intersections specified by the respondents. For the sake of efficiency, aerial distance was used in this case instead of network distance. A bus stop in the NJ TRANSIT shape file is a route-specific and location-specific point on a map, meaning that a bus stop location has 12 stops if six routes operating in two directions serve that location. As a result, the number of bus stops in this analysis is substantially greater than locations served by buses.

Figure 19 shows the proportion of respondents categorized by number of bus stops at specific distances. The smallest category of bus stop counts is no stop within half mile and the largest category is 100 or more stops. Consistent with Figures 17 and 18, it also shows that the current bus riders, on average, have more bus stops in the areas near their homes than the other three categories of respondents. On the other hand, the respondents who never used the bus have fewer bus stops than the other categories. According to the data shown in Figure 19, 31.9% of those who never used the bus did not have any bus stop within half mile, whereas only 6.3% of the current bus riders did not have a bus stop within that distance. Once again, the data show that the proximity to bus stops for those who stopped before and after COVID fall in an intermediate range when the variable considered is number of bus stops within a half mile. On the whole, there appears to exist evidence showing that proximity to bus stops, whether measured by distance or walk time, is an important factor influencing bus use.

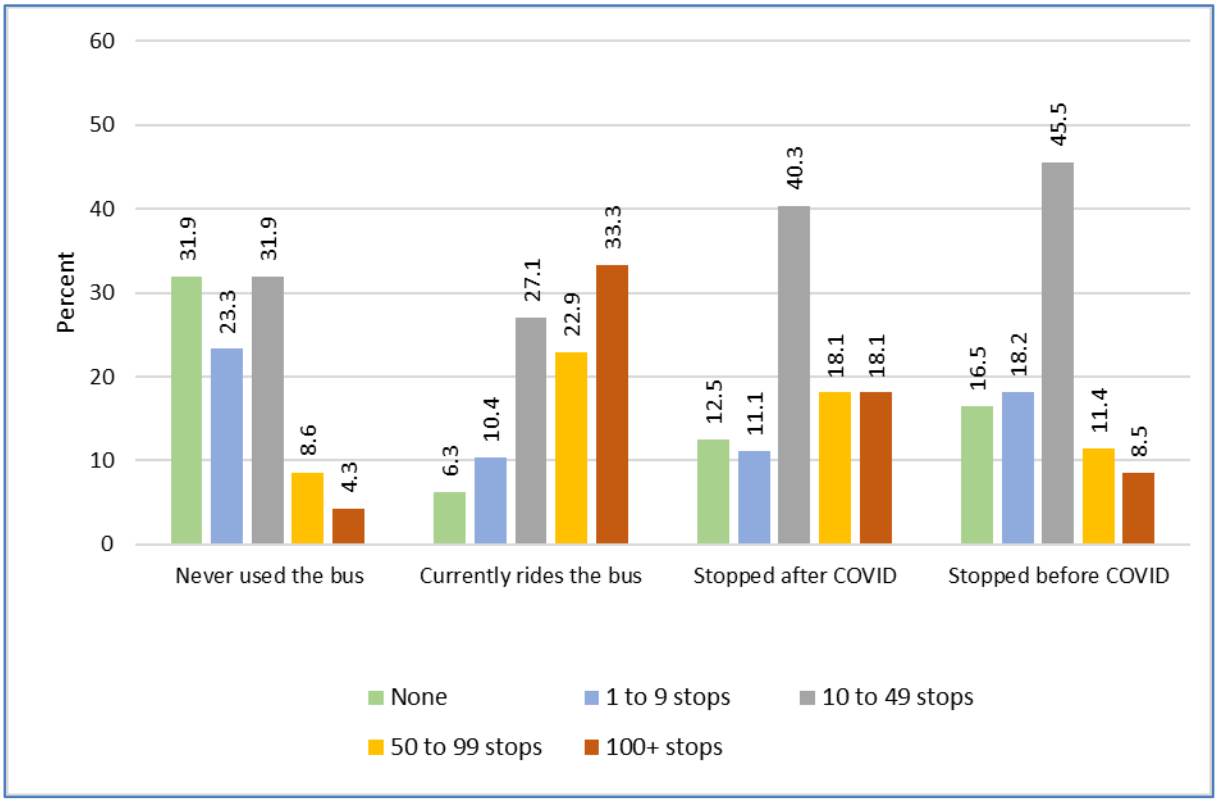


Figure 19. Number of one-way route-specific bus stops within half mile

A Model Comparing the Respondent Categories

Common sense suggests that the more similar the characteristics of the bus non-users are to the characteristic of the bus users, the more likely the former group would be to use the bus at some point in time. For that reason, a statistical model was used to examine the differences between the four categories of respondents. The two previous

sections showed that the current bus riders are different from the other groups in terms of certain socioeconomic characteristics and proximity to the bus network. Although some variables showed differences between the groups when each variable was compared individually, that does not mean that the groups are significantly different when all characteristics of the groups are compared collectively. A conventional way to make such a collective comparison is to use a multivariate model where several variables are used as explanatory variable to predict one variable, called the dependent variable.

The dependent variable in the current context is categorical, classified into four categories: respondents who currently ride the bus, respondents who stopped after COVID, respondents who stopped before COVID, and respondents who never used the bus. Thus, the model predicts the likelihood of an individual belonging to one of the four categories based on their characteristics. However, in the current context, distinguishing the categories based on the explanatory variables is more important.

The model used to compare the four categories of respondents is a multinomial logit model (MNL). An MNL model is run by taking one category as the base category. The model was run three times by taking one category as the base each time. However, because the intent of the modeling effort is primarily to distinguish the current riders and the persons who never used the bus, the results of only two models are presented, the first comparing the current riders and the second comparing the persons who never used the bus. Thus, the model results comparing the current riders are presented in Table 3 and the model results comparing the persons who never used the bus are presented in Table 4.

The three columns for each category in Table 3 are the variable coefficients (β), significance level of the variable (p), and the odds ratio (OR), which is expressed as e^{β} or the antilog of β. The plus or minus sign of β indicates whether the variable is positively or negatively associated with the dependent variable, p indicates whether the association is statistically significant (p value <0.05 is considered significant at the 5% level). The OR indicates the difference from the comparison category. For example, for the first model in Table 3, the +0.530 for female indicates that females are more likely to never have used the bus, 0.010 indicates that the variable is significant at the 5% level (because it is smaller than 0.05), and the OR of 1.70 indicates that females are 70% more likely to never have used transit compared to males (the difference between the OR and 1 is conventionally expressed as percent difference).

The parameters for the variables that are significant at the 5% level are shown in bold font in Table 3 to distinguish them from the other variables. Because the first model in the table compares those who never used the bus with those currently use the bus (the base category), one can infer from the results that:

- Females are 70% **more likely** to never have used the bus than being a current bus rider (or women are 70% less likely to be a current rider than never to have used the bus)

- People aged 62+ are 149% **more likely** to never have used the bus than being a current bus rider
- White people are 71% **more likely** to never have used the bus than being a current bus rider
- African American people are 55% **less likely** to never have used the bus than being a current bus rider
- People from households without a car are 88% **less likely** to never have used the bus than being a current bus rider
- People from households with 3+ cars are 210% **more likely** to never have used the bus than being a current bus rider
- People from households with less than $50,000 income are 51% **less likely** to never have used the bus than being a current bus rider
- People living within a 10-minute walk from the nearest bus stop are 47% **less likely** to never have used the bus than being a current bus rider
- People whose walk from home to the nearest bus stop is 20 minutes or more (or people who do not know where the nearest bus stop is, or how long it takes walk there) are 418% **more likely** to never have used bus than being a current bus rider.

Thus, the differences between the current bus riders and the people who have never used the bus pertain to gender, age, race, cars in household, household income, and walking time to the nearest bus stop. The direction of the relationship of each variable is intuitive. For example, females, older people, White people, people with three or more cars, and people living beyond a 20-minute walk from the nearest bus stop are significantly more likely never to have used the bus than being a current bus rider, whereas African Americans, people without a car in household, people with less than $50,000 household income, and people living within a ten-minute walk from the nearest bus stop are more likely to be a current rider than to never have used the bus. The other variables included in the model, including Hispanic ethnicity, education, and occupation, are not statistically significant, meaning that there is no significant difference between the comparison groups in terms of these variables.

The second model in Table 3 compares the people who stopped riding the bus after COVID with the current bus riders. It is not surprising that only three variables are significant in the model because those who stopped after COVID were bus riders not too long ago. The model results show that

- People from households without a car are 71% **less likely** to have stopped after COVID than being a current bus rider
- People from households with 3+ cars are 134% **more likely** to have stopped after COVID than being a current bus rider
- People living within 10-minute walk from nearest bus stops are 51% **less likely** to have stopped after COVID than being a current bus rider.

Table 3 – MNL model comparing current bus riders with other three categories

Variables	Never used the bus			Stopped after COVID			Stopped before COVID		
	β	p	e^{β}	β	p	e^{β}	β	p	e^{β}
Intercept	0.974	0.041		-0.025	0.964		0.826	0.086	
Female	**0.530**	**0.010**	**1.70**	0.367	0.131	1.44	0.240	0.248	1.27
Age 18 to 34	-0.300	0.205	0.74	0.332	0.220	1.39	0.007	0.976	1.01
Age 35 to 61 [Referent]									
Age 62 and over	**0.913**	**0.004**	**2.49**	0.456	0.245	1.58	**1.170**	**<.001**	**3.22**
White	**0.534**	**0.050**	**1.71**	-0.202	0.518	0.82	0.222	0.420	1.25
Black or African American	**-0.797**	**0.018**	**0.45**	-0.525	0.149	0.59	-0.350	0.274	0.70
Asian, multiracial, and others [Referent]									
Hispanic	-0.489	0.073	0.61	-0.387	0.217	0.68	-0.377	0.164	0.69
No car in household	**-2.113**	**<.001**	**0.12**	**-1.230**	**<.001**	**0.29**	**-1.774**	**<.001**	**0.17**
One or two cars on household [Referent]									
Three or more cars in household	**1.131**	**<.001**	**3.10**	**0.851**	**0.023**	**2.34**	**0.998**	**0.002**	**2.71**
Full-time worker	-0.170	0.502	0.84	0.049	0.872	1.05	-0.067	0.792	0.94
Part-time worker	-0.294	0.433	0.75	0.747	0.056	2.11	0.107	0.767	1.11
Retired, home makers, unemployed, etc. (Referent]									
Did not pursue college	-0.032	0.906	0.97	-0.237	0.459	0.79	-0.142	0.598	0.87
Attended college but did not acquire bachelor's degree [Referent]									
Bachelor's degree or higher	0.007	0.979	1.01	0.052	0.869	1.05	-0.262	0.331	0.77
Income less than $50,000	**-0.705**	**0.009**	**0.49**	0.113	0.712	1.12	-0.020	0.939	0.98
Income between 50,000 and $100,000 [Referent]									
Income $100.000 or over	0.046	0.868	1.05	-0.190	0.583	0.83	0.045	0.876	1.05
Walk takes less than 10 minutes to nearest bus stop	**-0.629**	**0.011**	**0.53**	**-0.716**	**0.012**	**0.49**	**-0.719**	**0.003**	**0.49**
Walk takes between 10 and 19 minutes [Referent]									
Walk takes 20 minutes or more or does not know how long it takes	**1.645**	**<.001**	**5.18**	0.898	0.053	2.46	**0.854**	**0.044**	**2.35**
Total N	1073								
Pseudo R-Square	0.332								

Note: Parameters for variables significant at <5% are shown in bold font

The third model shown in Table 3 compares the people who stopped riding the bus before COVID with the people who currently ride the bus. Instead of just three variables, five

variables are significant in this model, indicating that the people who stopped before COVID are different from the current riders in more ways than the people who stopped after COVID are. The two variables that were not significant in the second model but are significant in the third model are people aged 62+ and people living 20 minutes of walk time or more from the nearest bus stop.

The results comparing the respondents who never used the bus with the other categories are shown in Table 4. In this specification of the model, the category representing the respondents who never used the bus is used as the base category. The table shows only the results for the riders who stopped after COVID and the riders who stopped before COVID, but not the current riders, because the results for the current riders are simply the reverse of the results of the model comparing the current riders and the respondents who never used the bus, shown as the first model in Table 3.

The most important observation one can make from Table 4 is that the respondents who never used the bus are more different from the riders who stopped riding the bus after COVID than the riders who stopped riding before COVID. That is because as many as six variables are statistically significant in the model comparing the respondents who never used the bus with the riders who stopped after COVID, but only two variables are significant when a comparison is made with the riders who stopped before COVID. The first comparison shows that people aged 18 to 34, people from households with no cars in household, part-time workers, and people with less than $50,000 income are more likely to have stopped after COVID instead of never to have used the bus, whereas White people and people whose nearest bus stop is beyond a 20-minute walk are less likely to have stopped after COVID. The comparison of those who stopped before COVID shows that only two variables make them different from the respondents who never used the bus; while people with income less than $50,000 are more likely to have stopped before COVID, the people whose nearest bus stop is beyond a 20-minute walk are less likely to have stopped before COVID.

The substantially different characteristics of the people who never used the bus compared to the people who currently ride the bus indicate that it would be harder to attract the non-riders to the bus than the riders who stopped riding the bus. The greater similarity of the riders who stopped after COVID with the current riders and their greater dissimilarity with respondents who never used the bus indicate that, among the three categories that do not currently ride the bus, it would be the easiest to attract the riders who stopped after COVID. Considering that only in two regards the riders who stopped before COVID are different from those who never used the bus, it would be more difficult to attract them to the bus than the riders who stopped after COVID. However, those who stopped before COVID have an advantage over those who never used the bus in terms of proximity to the nearest bus stop.

Table 4 – MNL model comparing those who never used the bus with those who stopped riding the bus

Variables	Stopped after COVID			Stopped before COVID		
	β	p	e^{β}	β	p	e^{β}
Intercept	-0.999	0.038		-0.147	0.688	
Female	-0.163	0.448	0.85	-0.290	0.073	0.75
Age 18 to 34	**0.632**	**0.009**	**1.88**	0.308	0.119	1.36
Age 35 to 61 [Referent]						
Age 62 and over	-0.457	0.162	0.63	0.257	0.219	1.29
White	**-0.736**	**0.008**	**0.48**	-0.312	0.167	0.73
Black or African American	0.272	0.448	1.31	0.447	0.136	1.56
Asian, multiracial, and others [Referent]						
Hispanic	0.102	0.727	1.11	0.112	0.635	1.12
No car in household	**0.883**	**0.033**	**2.42**	0.339	0.353	1.40
One or two cars on household [Referent]						
Three or more cars in household	-0.279	0.283	0.76	-0.132	0.470	0.88
Full-time worker	0.219	0.419	1.24	0.103	0.602	1.11
Part-time worker	**1.041**	**0.002**	**2.83**	0.401	0.156	1.49
Retired, home makers, unemployed, etc. (Referent]						
Did not pursue college	-0.205	0.489	0.82	-0.109	0.616	0.90
Attended college but did not acquire bachelor's degree [Referent]						
Bachelor's degree or higher	0.045	0.867	1.05	-0.269	0.173	0.76
Income less than $50,000	**0.818**	**0.003**	**2.27**	**0.685**	**0.001**	**1.98**
Income between 50,000 and $100,000 [Referent]						
Income $100.000 or over	-0.235	0.404	0.79	-0.001	0.998	1.00
Walk takes less than 10 minutes to nearest bus stop	-0.088	0.727	0.92	-0.091	0.635	0.91
Walk takes between 10 and 19 minutes [Referent]						
Walk takes 20 minutes or more or does not know how long it takes	**-0.747**	**0.013**	**0.47**	**-0.791**	**<.001**	**0.45**

Note 1: Parameters for variables significant at <5% are shown in bold font
Note 2: Total N and Pseudo R-Square are not shown because they are the same as Table 3

Other Distinct Characteristics of Current Bus Riders

The comparison of demographic and socioeconomic characteristics of the current bus riders with the other respondent categories clearly showed their distinctiveness. Additional analysis of the survey data showed similar distinctiveness in some other

regards. First, when compared with respondents who never used the bus and those who stopped using the bus, the current bus riders are more prone to using Uber and Lyft for almost all trip purposes except for trips for recreation and entertainment. Second, the current bus riders are also more prone to making walking trips than the other respondent categories. Only for work and school trips, the riders who stopped after COVID made a greater proportion of trips by walking. The greater proportion of trips by Uber and Lyft and walking by the current bus riders for most trip purposes is most likely the result of having lower access to vehicles in household. However, the greater proportion of walking trips by those who currently ride the bus could also be the result of greater walkability in their neighborhoods, defined by sidewalks, crosswalks, signalized intersections, storefronts, etc.

Third, the current bus riders make a greater proportion of trips in off-peak periods of weekdays, as well as during weekends, than the riders who stopped riding the bus before and after COVID. Although the proportion of current riders reporting bus use during 4 AM to 6 AM and 6 AM to 9 AM on weekdays is similar to the riders who stopped riding, their proportion is significantly higher from 9 AM to 6 PM on weekdays and for both Saturdays and Sundays.

Consideration of Bus Use by Bus Non-Users

The 579 respondents who never used the bus were asked a few questions to examine their consideration of bus use and the perception of NJ TRANSIT bus. Of the 569 of those respondents who answered a question inquiring whether they ever considered using the bus, 144 (25.3%) mentioned that they had considered, whereas 425 (74.7%) mentioned that they had not considered. Because the respondents who considered using the bus have greater likelihood of using the bus than those who did not consider, an attempt was made to compare the characteristics of those who considered and those who did not consider bus use. The expectation was that the characteristics of those who did not consider bus use would be similar to the characteristics of those who never rode the bus, whereas the characteristics of those who considered will tend to be somewhat similar to those currently use the bus or stopped riding the bus.

Most of the variables showed results one would expect from the comparison of the four respondent categories. For example, White bus non-users are less likely to consider bus use (23.2%) than the average for all races (25.3%), whereas African American non-users (28.2%), Asian non-users (33.3%) and mixed-race non-users (34.3%) are more likely to consider bus use. Similarly, bus non-users aged 18 to 34 are more likely to consider (33.5%), whereas non-users aged 62+ are less likely to consider (18.5%). While 42.9% of the non-users from households without a vehicle considered bus use, only 21.0% of those from households with three vehicles and 17.9% of those from households with four or more vehicles considered bus use. When 32.4% of the bus non-users living within a 10-minute walk of bus stops considered bus use, only 18.8% of those living beyond a 20-minute walk did so. Thus, the characteristics that distinguish the respondents who never

used the bus from the other three respondent categories are mostly the same as the characteristics that distinguish the bus non-users who considered bus use from those who did not consider.

Despite the above variables showing results consistent with the prior analysis, two variables showed results that contradict intuition. First, while the model predicted that women are more likely to never have used the bus than being a current rider, a larger proportion of female bus non-users considered bus use (29.7% for females compared to 21.7% for male and non-binary combined). Second, while the cross-tabulation of Hispanic ethnicity showed that Hispanics are more likely to be a current rider than being a non-rider, among the bus non-users, they are slightly less likely to consider bus use than non-Hispanics (24.7% versus 25.8%).

Potential Trip Purpose of Bus Non-Users Who Considered Bus Use

For the provision of bus service to people who have not used the bus in the past, it is important to learn how they currently travel and how they would like to travel by bus. Learning about potential trip purposes of the bus non-users is particularly important in this regard because the purposes for which they wish to travel by bus may not be the purposes for which they make frequent trips. To make such a comparison, the respondents who never used the bus were asked in the survey about the purposes of the trips they make most often. The responses are presented separately for those who considered bus use and those who did not consider bus use in Figure 20. It shows that the most common trips by both groups are for the purposes of work or school trips, followed by trips to shops and stores. Trips for every other purpose account for much smaller proportion with a combined total of approximately 30-32% of all trips.

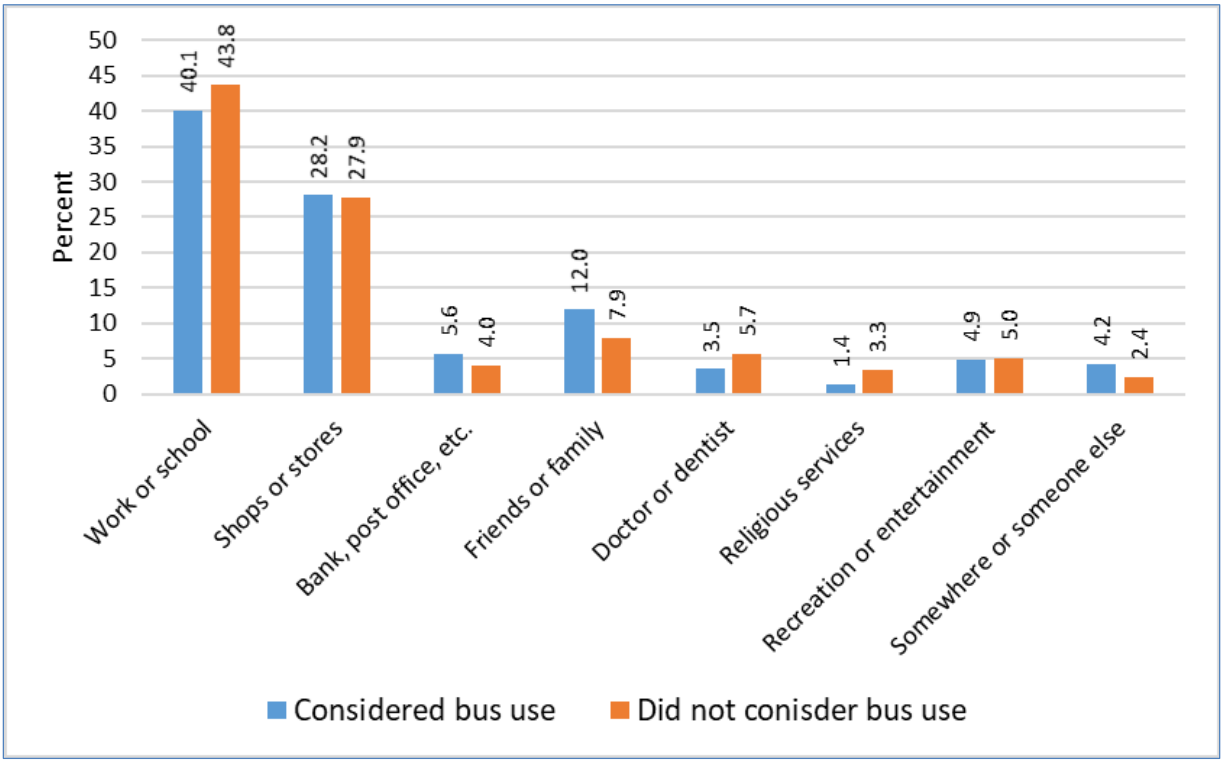


Figure 20. Purposes of most-often made trips by respondents who never used the bus

The respondents who never used the bus but considered using the bus were subsequently asked about the purposes for which they considered making trips by the bus. Their responses are summarized in Figure 21. It shows that the recreation and entertainment trip purpose was selected most often, followed by trips to work or school, and shops and stores, respectively. A comparison with Figure 20 shows that recreation and entertainment—the most commonly-selected bus trip purpose in Figure 21 at 29.7%—was selected as the most common trip purpose by only 4.9% of those who considered bus use and 5.0% of those who did not consider bus use. While trips to work or school and shops and stores rank high as trip purposes in both Figure 20 and Figure 21, recreational and entertainment trips account for a much larger proportion of bus trips compared to trips made currently. It implies that many bus non-users who consider using the bus consider it as a travel option for trips to recreational activities or entertainment events only (e.g., beaches, sporting events, concerts, etc.). Although this finding clearly displays a specific want of bus non-users, it also shows that many non-users may be considering the use of bus only for discretionary and infrequent activities. Even if services are provided to meet those wants, because of the infrequent nature of recreational and entertainment trips compared to trips for work, shopping, etc., such provisions may not help to substantially improve aggregate bus ridership.

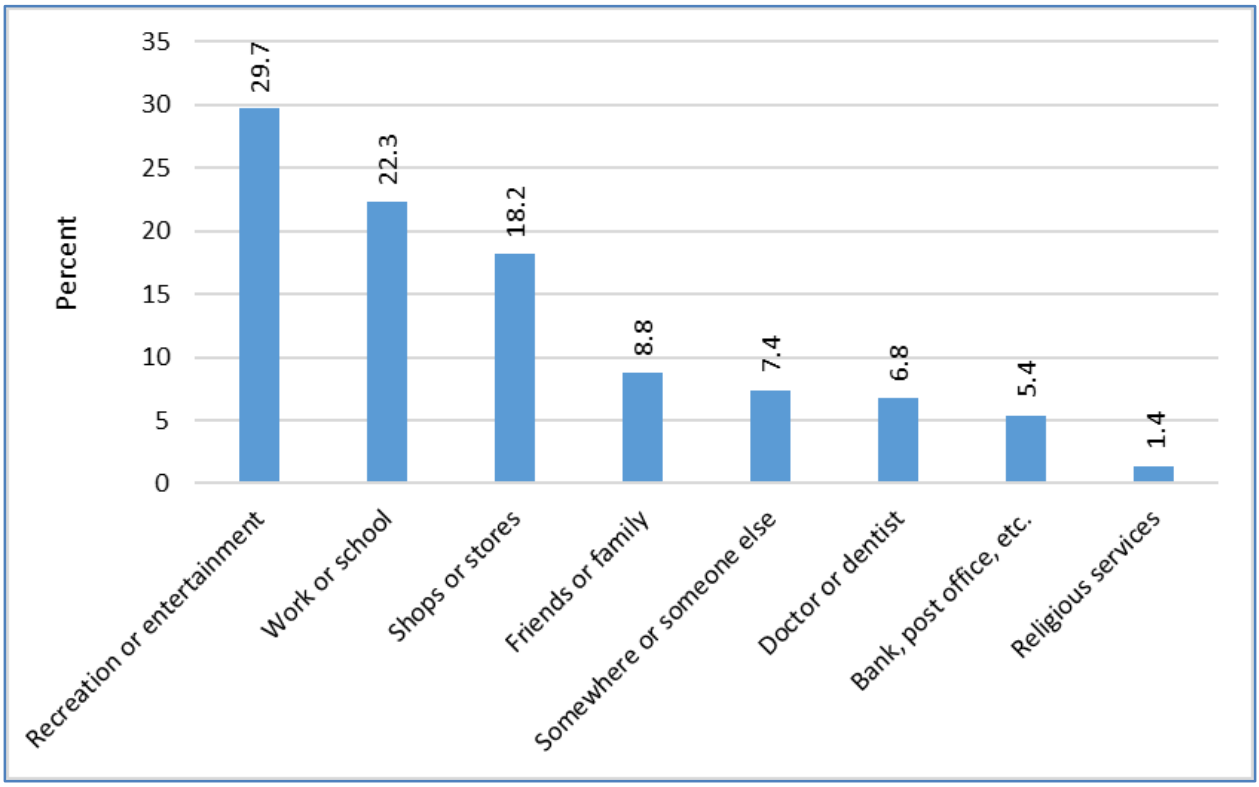
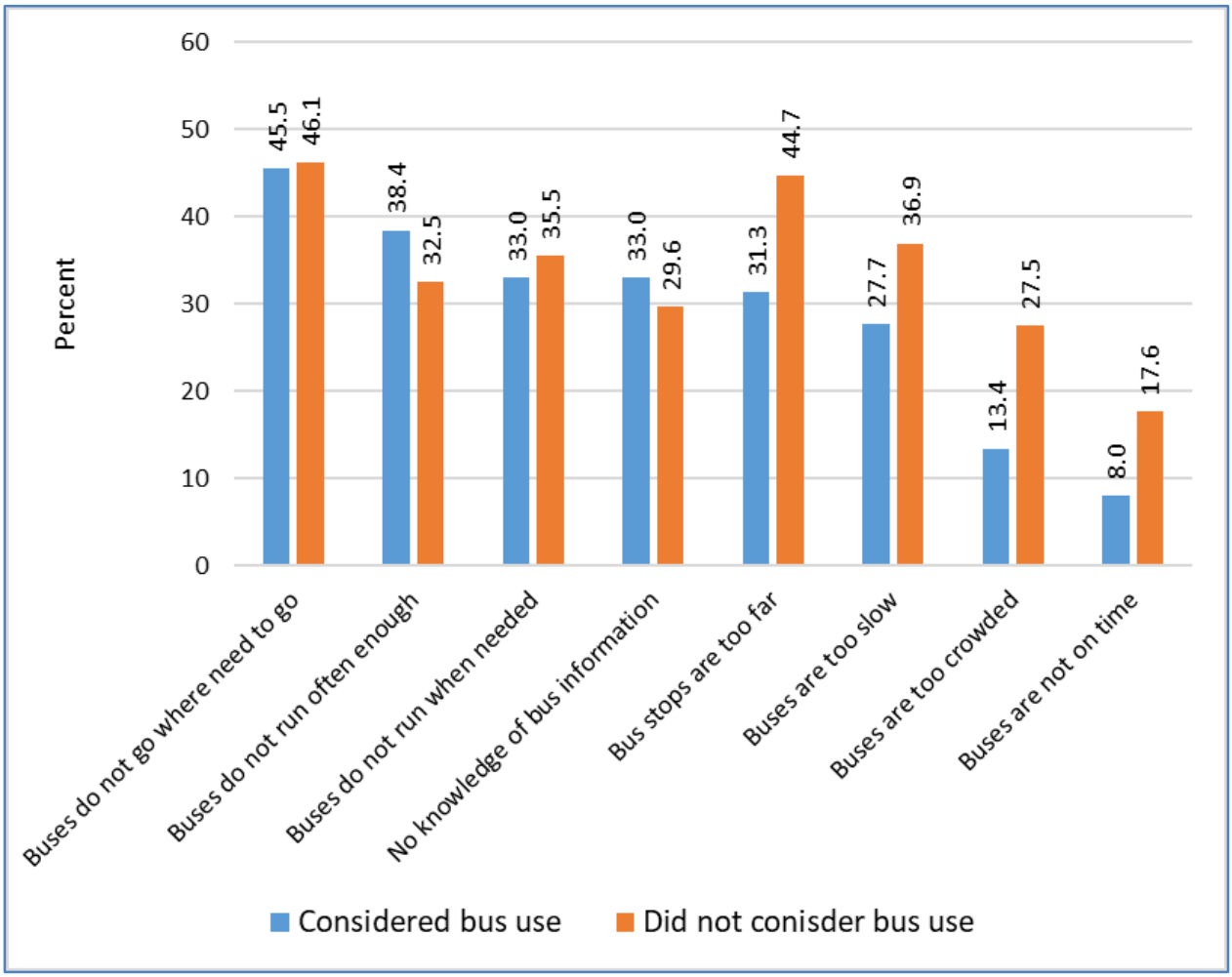


Figure 21. Purposes of bus trips considered

Reasons for Not Using the Bus

The survey respondents who mentioned considering the use of NJ TRANSIT bus were subsequently asked if they in fact used the bus after consideration. A total of 134 responded to the question and 112 (83.6%) reported not using it. Those who did not use the bus were asked why they did not use the bus after consideration. Similarly, the bus non-users who did not consider using the bus were asked about the reasons for not considering. In both questions, the same set of options were given to choose from, allowing a comparison of the responses. The responses, presented in Figure 22, can be used to assess the perception of the bus non-users about NJ TRANSIT bus. It shows that both groups are most concerned about buses not going where they need to go (45.5% and 46.1%). The second highest concern for those who considered bus use is bus frequency, but for those who did not consider, it is the proximity to bus stops. It shows, once again, that consideration of bus use is highly dependent on proximity to bus stops. The figure also shows that those who did not consider bus use are significantly more concerned than those who considered bus use about buses being too slow, buses being too crowded, and buses not being on time. For the last two, the proportion for those who did not consider bus use is more than twice that of those who considered bus use.



Note: Because the percentages are proportions of respondents selecting multiple options, the sum of the percentages far exceed 100% for both categories.

Figure 22. Reasons for not using the bus

Comparison of Bus Attributes to the Most Often Used Travel Mode

All 579 respondents who said they never used the bus were asked to compare their perceived bus trip performance with the performance of the mode they most often use. The respondents' comparison of perceived travel time difference between the bus and the most often used mode is shown in Figure 23, the comparison of convenience is shown in Figure 24, the comparison of perceived comfort is shown in Figure 25, the comparison of perceived cost of trips is shown in Figure 26, and the comparison of perceived reliability of on-time performance is shown in Figure 27. In all five figures, the responses are shown separately for those who considered using the bus and those who did not consider using the bus. The figures exclude the respondents who selected "Don't know" for answer.

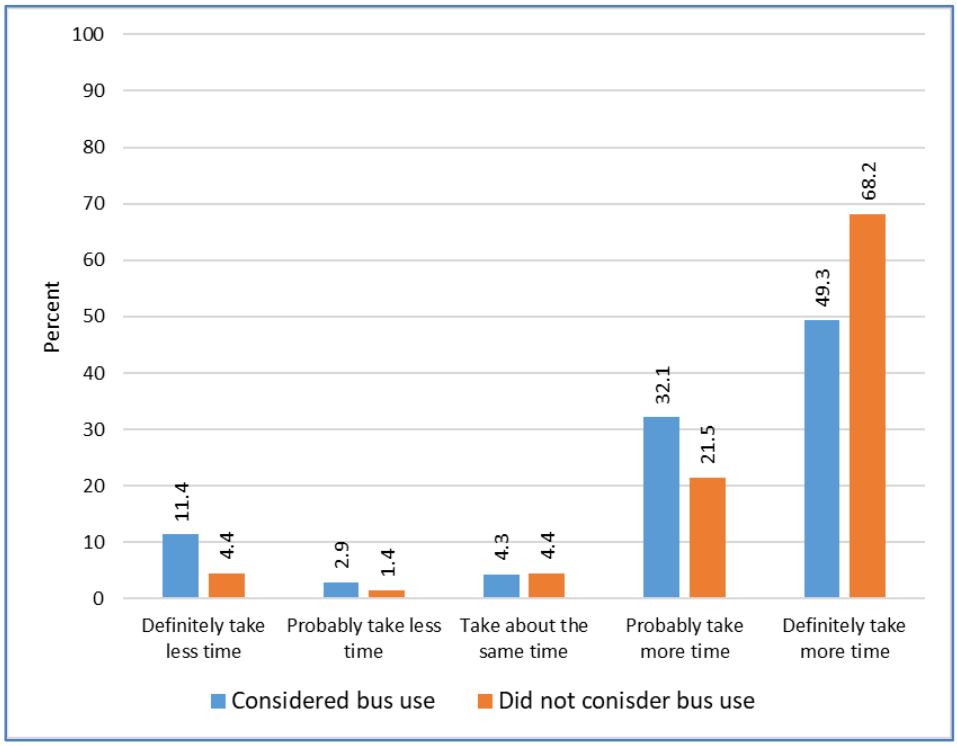


Figure 23. Comparison of bus trip travel time with most-often used mode

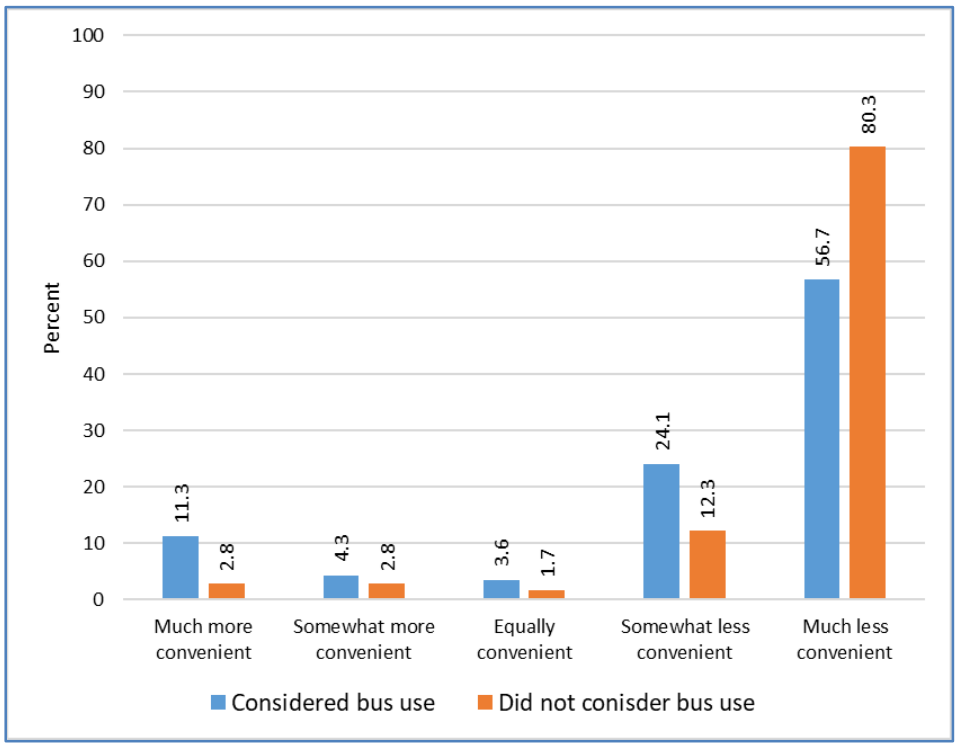


Figure 24. Comparison of bus trip convenience with most-often used mode

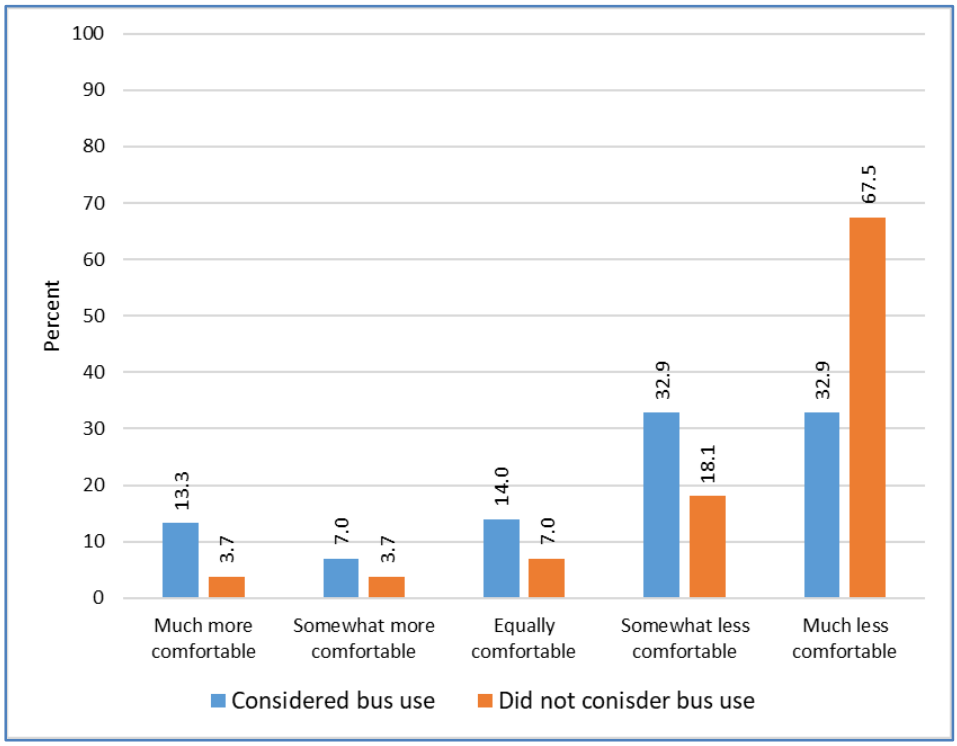


Figure 25. Comparison of bus trip comfort with most-often used mode

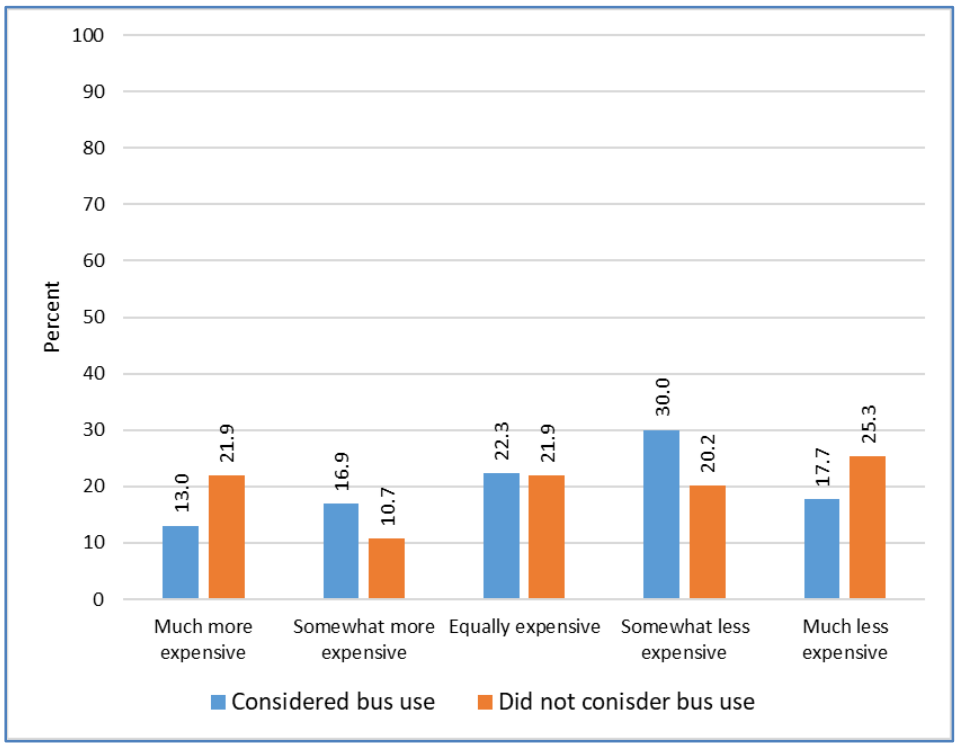


Figure 26. Comparison of bus trip expense with most-often used mode

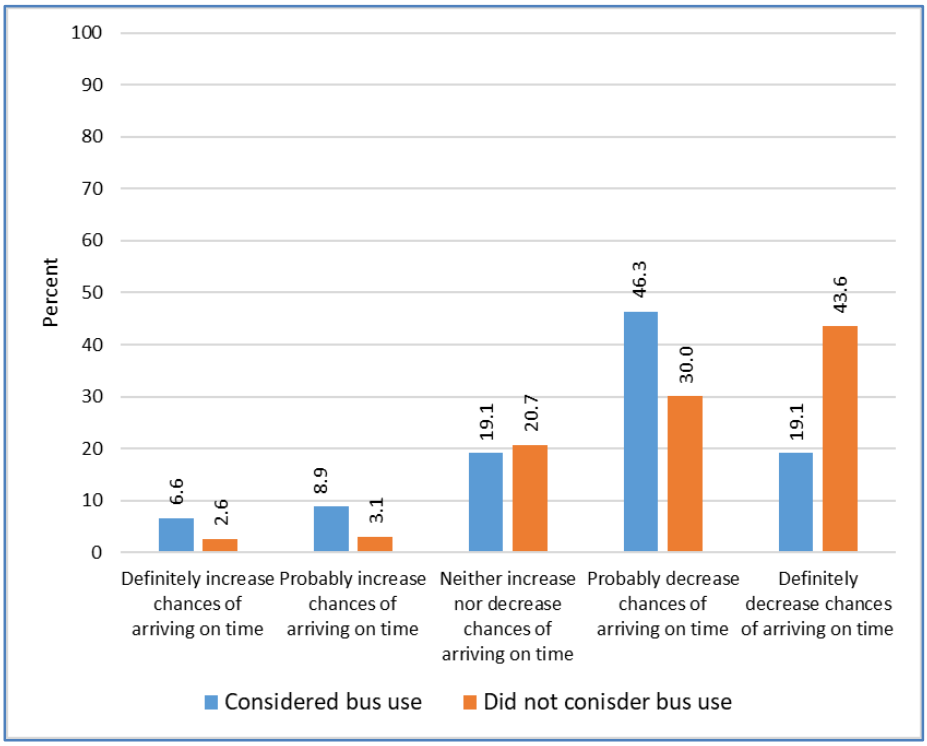


Figure 27. Comparison of bus trip reliability with most-often used mode

A much larger proportion of both groups of respondents perceived bus to be a worse travel option compared to the mode they use most often regarding all measures in Figures 23 through 27, except for trip cost, shown in Figure 26. A comparison of the figures shows that the respondents who did not consider bus use have a more negative perception of the bus than the respondents who considered using the bus. For example, regarding travel time, 68.2% of those who did not consider bus use perceived a bus trip would take more time compared to only 49.3% of those who considered bus use. Regarding, convenience, 80.3% of the former group and 56.7% of the latter group perceived a bus trip would be much less convenient. Regarding comfort and reliability also similar differences can be observed.

It is apparent from a comparison of the figures that, to make the bus competitive with the travel mode the bus non-users commonly use, bus service planning should place the highest priority on convenience, followed respectively by travel time, comfort, and reliability. In contrast to these attributes, bus trip expense seems to be less important for the non-riders. A reason for that could be that they have a high income on average.

Potential Bus Trips by Bus Non-Users: Where and When?

To examine what improvements to bus service would attract the respondents who never used the bus, they were given a set of hypothetical improvements and asked if those improvements would encourage them to use the bus. The responses to the question are

summarized in Table 5. Combined data for those who considered using the bus and those who did not consider using the bus, presented in the last column of the table, show that more direct buses within New Jersey would encourage more respondents (55.9%) than any other improvement. The share of respondents who selected this improvement was greater than the second most selected improvement (more frequent buses) by 11.1 percentage points. Thus, the most important need for the bus non-users is direct service to destinations, which is easily made possible by automobiles but not fixed-route buses. The table also shows that the number of respondents who selected more frequent buses, more or improved bus stops or terminals, better connection between bus routes, better connection between rail and bus, and more or improved park-and-ride facilities is almost equal.

Table 5 – Improvements that would encourage bus non-users to the bus

	Considered bus use		Did not consider bus use		Total	
	Respondents	Percent	Respondents	Percent	Respondents	Percent
More direct buses to places within New Jersey	113	78.5	205	48.2	318	55.9
More frequent buses	88	61.1	167	39.3	255	44.8
More or improved bus stops or terminals	89	61.8	165	38.8	254	44.6
Better connection between bus routes	89	61.8	164	38.6	253	44.5
Better connection between rail and bus	88	61.1	156	36.7	244	42.9
More or improved park-and-ride facilities	83	57.6	157	36.9	240	42.2
More bus stops	79	54.9	142	33.4	221	38.8
Fewer bus stops	42	29.2	97	22.8	139	24.4
N	144		425		569	

It is important to note from Table 5 that the proportions for those who considered using the bus are much larger than the proportions for those who did not consider using the bus for all bus attributes. For example, when 78.5% of those who considered using the bus believed that they would be encouraged to use the bus with more direct buses to destinations, only 48.2% of those who did not consider using the bus believed that they would be encouraged. Large differences can be similarly observed for increased bus frequency, improved bus stops and terminals, better connection between bus routes, more and improved park-and-ride facilities, and more bus stops. The lower likelihood of being encouraged to use the bus for those who have not considered using the bus may

be the result of the stronger negative perceptions they hold about the bus regarding convenience, travel time, and comfort. Lower proximity to nearest bus stops may be yet another factor.

All respondents who never used the bus were also asked for what purposes they would ride the bus if they were to make bus trips. Their responses are presented in Figure 28. Although the response options are mostly similar, Figure 28 is different from Figure 21 because (a) it shows responses for all respondents who never used the bus whereas Figure 21 showed responses from only those who considered using the bus, (b) it shows responses to questions on hypothetical trip purposes, whereas Figure 21 showed responses pertaining to trips considered by the respondents, and (c) it includes a response category for those who would not make a bus trip for any purpose, whereas that option was irrelevant in Figure 21 because it was about considered trips only.

Figure 28 shows that the respondents who never used the bus perceive the bus most commonly as a mode of travel to recreational activities and entertainment events as well as work or school (each accounting for 23.8%). They are followed closely by trips to shops and stores (18.1%), but the proportional share of the other purposes is low. A comparison of results in Figure 28 with the results in Figure 21 shows that the share of riders was greater for recreational activities and entertainment events among those who considered the use of bus (29.7%) despite the three top ranked trip purposes being the same. Unfortunately, Figure 28 shows that the proportion of respondents who mentioned that they would not ride the bus for any of those purposes was not negligible (13.1%), indicating that about one of seven or eight adults in New Jersey who have never used the bus cannot find a purpose to use the bus.

Another question asked to the respondents was about the day of the week and time of the day when they would likely make their trips if they were to travel by NJ TRANSIT bus. Their answers to the question on travel day and time are presented in Figure 29. It shows that anytime Saturday accounted for the largest proportion (30.5%), followed by weekday midday 9 AM to 3 PM (28.1%). A reason for these large proportions is the longer duration for each (24 hours for Saturday and six hours between 9 AM and 3 PM on weekday), but it may also be partly because of the large share of respondents who perceived the bus as a travel mode to attend recreational activities and entertainment events. Yet the substantial proportion of respondents who selected weekday AM peak 6 AM to 9 AM (21.6%) is consistent with the reasonably large share of respondents who selected work and school trips in Figure 28 (23.8%) because most people go to work during that time period.

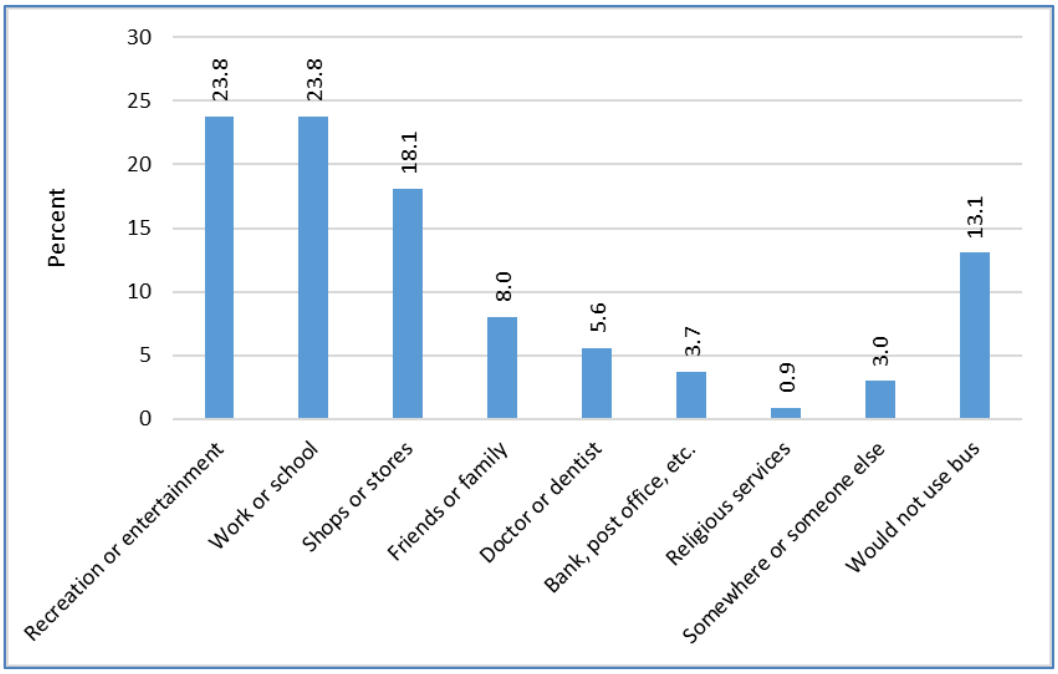


Figure 28. Potential trip purpose if bus non-users took bus trips

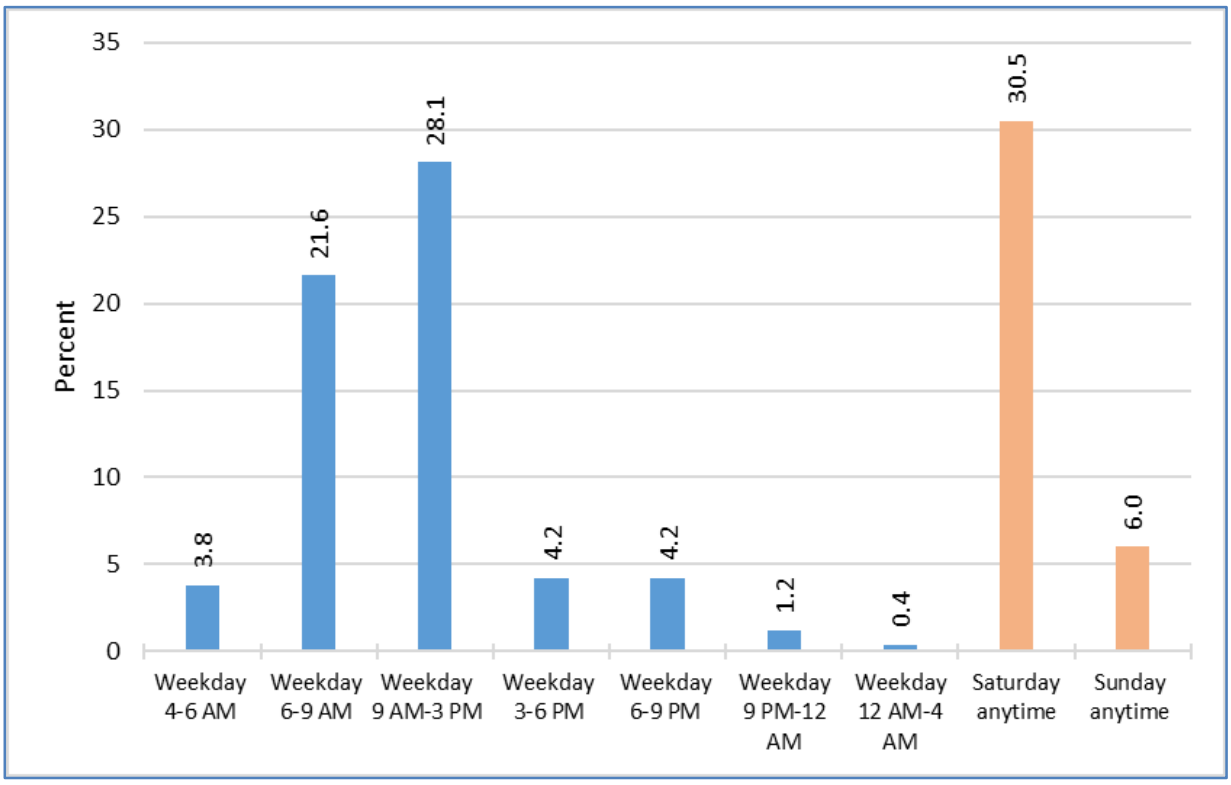


Figure 29. Potential day of the week and time of the day if bus non-users took bus trips

Finally, the respondents who never used the bus were asked about the places between which they would travel if they were to make trips by NJ TRANSIT bus. A total of 389 respondents provided the names of the first place and a total of 384 provided the names of the second place. Figure 30 shows the desire lines drawn from the responses of those who provided the names of both places. To draw the desire lines, the centroids of the municipalities (Minor Civil Divisions) were used at both ends.

Several observations can be made from the bus non-users' desired trips by bus. First, there is no discernible difference between the desired trip patterns of those who considered bus use and those who did not. Both groups' trip origins and destinations seem equally scattered and trip distances equally long. Second, the desire lines do not conform to the bus network for many respondents. In many places where the trips begin or end, there is not bus service. Furthermore, many desire lines run along the Northeast Corridor (New York–Trenton–Philadelphia), which is well-connected by rail, but not by bus. Third, many trip origins and destinations are located along the Jersey shore, where bus service is available, but not to the same extent as the places near New York City and Philadelphia. The large number of origins and destinations near the shore could be because of the large proportion of respondents whose trip purpose would be recreational.

Fourth, the trip distance for many desired trips seems longer than typical trips by NJ TRANSIT buses, especially local buses. Table 6 shows that mean trip distance for all respondents is 20.5 miles, but distances vary from county to county. That the trip distances of the bus trips desired by the bus non-users are longer than typical NJ TRANSIT bus trips can be fully comprehended by comparing the distances shown in Table 6 with distances of typical bus trips. For example, the mean network trip distance of NJ TRANSIT bus trips, estimated from the combined bus rider survey data for two studies by this research team that covered routes from Hudson County, Essex County, Morris County, Bergen County, Union County, and Monmouth County, was only 6.5 miles.[3] Thus, the mean trip distance of the desired trips is more than three times the distance of average bus trips. If the aerial distances in Table 6 were converted to network distances, the difference between actual NJ TRANSIT bus trips and bus trips desired by bus non-users would be significantly higher.

[3] https://rosap.ntl.bts.gov/view/dot/36898 and https://rosap.ntl.bts.gov/view/dot/43653

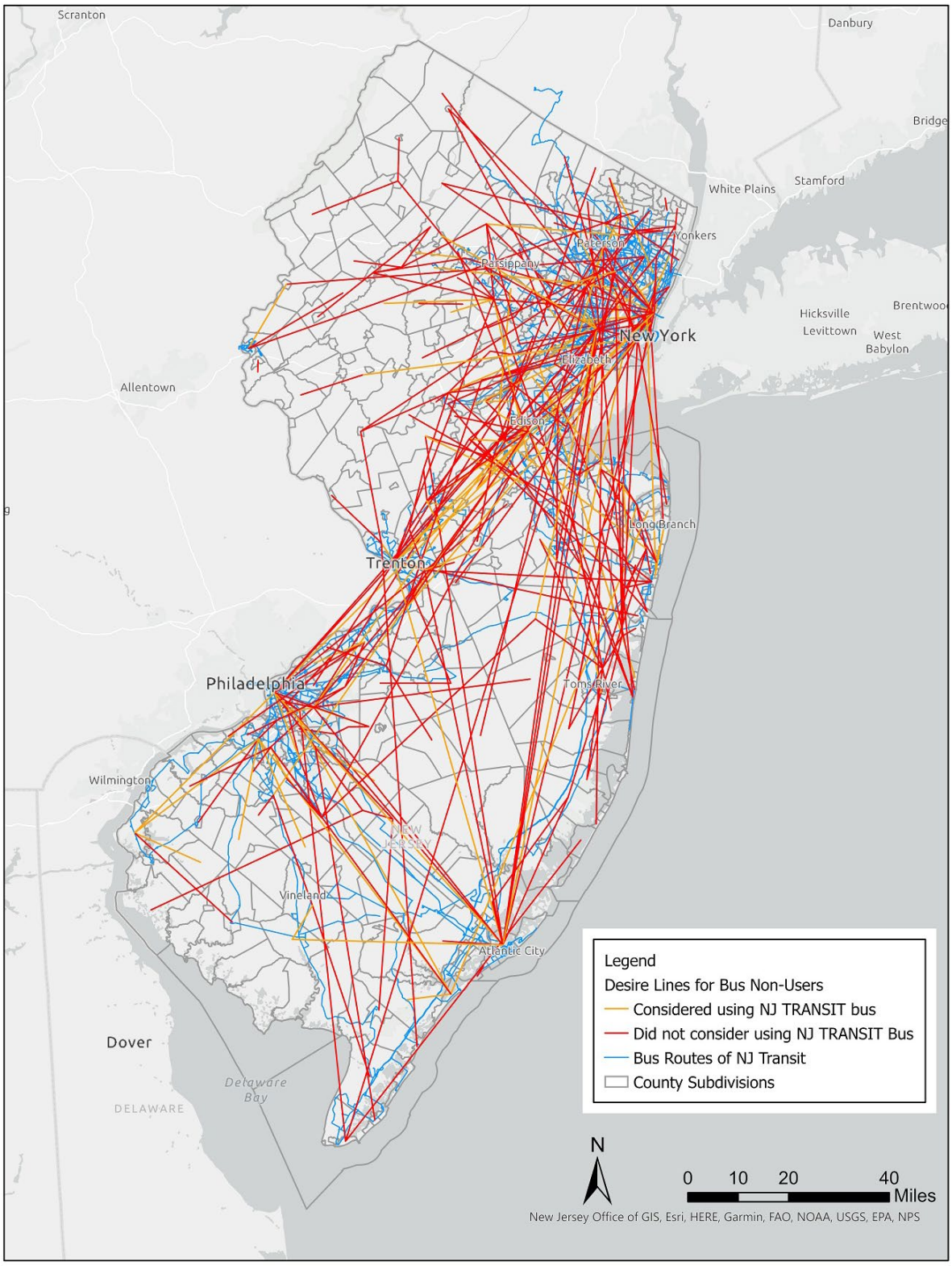


Figure 30. Desire lines between the places bus non-users would travel by bus

Table 6 – Distance of bus trips desired by bus non-users

Trip Origin County name	Mean Aerial Distance (Miles)	Std. Deviation	N
Atlantic	33.1	30.1	9
Bergen	24.2	33.5	30
Burlington	23.4	23.7	23
Camden	21.1	21.7	28
Cape May	32.5	41.2	4
Cumberland	24.4	24.6	4
Essex	11.0	14.9	21
Gloucester	20.0	17.3	15
Hudson	7.9	11.2	15
Hunterdon	34.3	28.2	8
Mercer	15.2	20.4	20
Middlesex	19.4	17.7	30
Monmouth	21.6	21.2	44
Morris	18.8	18.0	22
Ocean	27.9	24.9	24
Passaic	19.1	26.1	13
Salem	30.4	25.8	6
Somerset	14.8	18.2	18
Sussex	25.6	15.0	9
Union	17.9	17.8	16
Warren	12.5	9.4	10
Total	20.5	22.3	369

From the names of the origin and destination places for the desired bus trips by the bus non-users, one can observe that a large proportion of the trips would begin or end in communities other than the large cities and towns of the state. To illustrate this point, the places that were selected by at least four respondents as the first place, or the origin place origin, are shown in Table 7, and the places that were selected by at least four respondents as the second place, or the destination place, are shown in Table 8. In both cases, the number of places happen to be 14.

Table 7 – The top trip origins of desired bus trips

Serial No.	First place	Respondents	Percent
1	Jersey City	12	3.08
2	Newark	11	2.83
3	Atlantic City	9	2.31
4	Bridgewater	6	1.54
5	Hamilton Twp. (Mercer County)	6	1.54
6	Cherry Hill	5	1.29
7	Toms River	5	1.29
8	Trenton	5	1.29
9	Vineland	5	1.29
10	Camden	4	1.03
11	Edison	4	1.03
12	New Brunswick	4	1.03
13	New York City	4	1.03
14	Princeton	4	1.03
Total		84	21.59

Table 8 – The top trip destinations of desired bus trips

Serial No.	Second Place	Respondents	Percent
1	Newark	15	3.91
2	New York	15	3.91
3	New Brunswick	11	2.86
4	Trenton	11	2.86
5	Atlantic City	9	2.34
6	Hoboken	8	2.08
7	Jersey City	8	2.08
8	Edison	5	1.30
9	Morristown	5	1.30
10	Brick	4	1.04
11	Cherry Hill	4	1.04
12	Montclair	4	1.04
13	Philadelphia	4	1.04
14	Princeton	4	1.04
Total		107	27.86

Since a total of 389 respondents provided the names of the origin places and a total of 384 provided the names of the destination places, the percentages in the last column of each table are estimated by using these numbers as the denominator. It is not surprising that both tables include many of the largest cities of New Jersey (and New York City).

However, the cities and towns included in Table 7 account for only 21.6% of the place origins named by the respondents, whereas the cities and towns included in Table 8 account for only 27.9% of the destinations. Among the origin places named by the 389 respondents, 202 were selected by only one respondent, accounting for 51.9% of the desired trips. Similarly, among the destination places named by the 384 respondents, 180 were selected by only one respondent, accounting for 46.9% of the desired trips. Although these proportions are estimated from a sample of modest size, they do indicate that many of the desired bus trips would begin and/or end in geographically scattered small towns rather than large urban areas. To provide bus service to accommodate such trips may require NJTRANSIT to substantially expand its existing bus network, which may not be feasible without a substantial infusion of funding.

Conclusion

The survey of the general population of New Jersey that included current bus riders, people who never used NJ TRANSIT local bus, people who stopped riding the bus before COVID, and people who stopped riding the bus after COVID generated results that could be insightful for bus service planning. To begin with, the comparison of the socioeconomic characteristics of the four categories of respondents revealed that the current riders and the respondents who never used the bus are two extremes, whereas the respondents who stopped before COVID are more similar to those who never used the bus, and the riders who sopped after COVID are more similar to the current riders. Thus, to the extent socioeconomic characteristics influence people's decision to ride the bus, those who stopped after COVID would be more likely to ride the bus in the future than the other two groups of non-riders, and those who stopped before COVID would be more likely to use the bus than those who never used the bus. The greater proximity to bus stops near home for the riders who stopped riding before and after COVID also increases their likelihood of using the bus compared to the people who have never used the bus.

Second, the survey also revealed certain barriers to bus use for the respondents. A barrier to those who never used the bus is obviously proximity to bus stops near home. The analysis of walking time to bus stops, objective network distance, as well as number of bus stops within a half mile clearly indicated that the riders who never used the bus are at a clear disadvantage. A large proportion of bus non-users believe that buses do not go where they need to go, buses are not frequent enough, buses are not available when needed, and buses are too slow. Many of them also do not know where to get information about the bus. The analysis clearly indicated that the respondents who did not consider bus use are far more concerned about not having a bus stop near home than those who considered bus use.

Third, the comparison of the bus with the mode they most commonly use revealed that those who never used the bus are concerned about critical measures of bus trip performance. Their greatest concern appears to be lack of convenience, followed by travel time, comfort, and reliability. The only measure that did not seem to concern them

much was trip expense. The concern about convenience, travel time, comfort, and reliability indicates that these attributes are important for those who never used the bus, and they would use the bus if they believed that bus performance in these regards were comparable to whatever mode they currently use.

Fourth, the survey revealed what types of bus improvements would be attractive to the bus non-riders. First in their list is direct bus service to places within New Jersey, which was selected by a substantially larger number of respondents than other improvements. However, more frequent buses, improved bus stop/terminal amenities, better connection between bus routes, and improved park-and-ride facilities are also high on their list.

Fifth, an equal number of bus non-riders perceive the bus as a mode of travel to recreational and entertainment activities as the number that perceives it as a mode of travel to work and school. The bus non-riders thus contrast substantially from the current bus riders, who make frequent bus trips for work and school, but not for recreation and entertainment. The numerous geographically dispersed places mentioned as potential origins and destinations of bus trips by the bus non-riders also indicate that the bus service to accommodate their trips would have to be different in nature from typical bus trips at present. The substantially longer distance of the desired trips by the bus non-users is yet another indication that the service to accommodate the trips of the bus non-users would have to be different.

Finally, the survey provides some insights about the reasons for bus ridership decline. The statistically significant higher automobile ownership among the riders who stopped riding before and after COVID indicates that access to the car is an important factor in decisions to stop riding the bus. Although the observed relationship does not necessarily mean that higher automobile ownership caused people to stop riding, it is undeniable that there is an association between automobile access and discontinuation of bus use. The survey could not provide useful insights regarding ridehailing as a cause of bus ridership decline, but it showed that the people who currently ride the bus also use Uber and Lyft for more trip purposes than people who never used the bus and riders who stopped riding the bus. A reason for greater use of Uber and Lyft by the current bus riders most likely is that many current bus riders do not have access to a household vehicle. However, because of their residence in urban areas, many current bus riders may also have easier access to the ridehailing services than people who live in suburban and exurban areas.

CONCLUSIONS AND RECOMMENDATIONS

This research began before the COVID-19 pandemic impacted ridership the entire public transportation industry in the United States. The primary objective of this research was to identify the needs of the current and potential local bus riders in New Jersey. By some accounts, transit ridership declined nationally by 14% to 15% between 2012 and 2018. Average weekday bus ridership for NJ TRANSIT decreased by 7.5% and Saturday and

Sunday ridership decreased at an even higher rate in a five-year period between 2014 and 2019.

The original intent of this research was to identify strategies to address bus ridership decline by first identifying the needs of the current NJ TRANSIT bus riders, the bus riders who stopped riding in the pre-COVID world, and the people who never used the bus. However, because of the impact of the pandemic on the transit industry, the riders who stopped riding the bus because of COVID were included as a separate category of potential riders. Thus, the comparison categories for this research were the current riders, the people who never used the bus, the riders who stopped after COVID or because of COVID, and the riders who stopped before COVID or for reasons other than COVID.

The literature review showed that the proliferation of ridehailing services, increasing income and automobile ownership, and transit fare increases contributed to ridership decline in varying degrees. The interviews with transit agency representatives showed the different approaches they undertook to learn about the causes of ridership decline. More importantly, they showed the approaches agencies have undertaken to address ridership decline.

The online survey of bus riders and the telephone/mail survey of the New Jersey population showed that the current bus riders are socioeconomically disadvantaged compared to the riders who stopped riding the bus and the New Jersey residents who have never used the bus. Both surveys also indicated that access to an automobile is associated with people's use of the bus. This research also provided results consistent with past studies about the potential effect of ridehailing on bus ridership but drawing inferences about a causal relationship is difficult.

The two surveys provided important insights about the needs of the current bus riders and the potential bus riders. Survey responses from both current and past riders indicated that bus frequency, reliability, and travel time require the most attention. Potential bus riders who have never used the bus are highly interested in direct bus service to their destinations. They would also like the bus service to be convenient, comfortable, and reliable, but fare or trip cost is of lesser concern. Their bus trips would be longer than typical bus trips today. Their trip origins and destinations would be more dispersed than the origins and destinations of today's bus trips. Given the nature of the desired trips by the potential bus users who have never used the bus, bus network and service area expansion will most likely be required to accommodate their desired trips.

Based on findings from various tasks, the following recommendations are worth pursuing to address bus ridership decline in New Jersey:

- Prioritize retention of current riders over attracting new riders. If income and vehicle ownership among the current bus riders increase, some riders may stop riding the bus. The strategy can be justified based on the association between household income, vehicle ownership, and ridership decline. While city-specific studies

elsewhere have indicated that many traditional bus riders discontinued riding the bus as their income rose and they began to drive, the surveys conducted as part of this study strongly indicated an association between income, automobile use, and discontinuation of riding the bus.

- Focus on providing better service in areas already served by local buses. This strategy has been adopted by some of the interviewed agencies and the reviewed literature. Furthermore, all the reasoning provided for prioritizing retention over attracting new riders apply to this recommendation.
- Pay most attention to the needs of the current riders, followed respectively by the needs of the riders who stopped riding after COVID, the riders who stopped riding before COVID, and the people who have never used the bus. This strategy can be justified based on the socioeconomic differences between the four groups and differences in bus-stop proximity among the groups. Because of their residential location in predominantly suburban areas far from the existing bus network, lack of bus stops near home, and negative perceptions about bus performance, the riders who have never used the bus will be the least likely to use the bus unless bus service is widely expanded geographically, and service quality is improved drastically.
- Prioritize bus frequency over other transit improvements because both past riders and current riders overwhelmingly believe that bus frequency decreased between the first time they used the bus and the last time they used the bus. Furthermore, bus frequency was the variable that was considered the most by the riders who stopped riding the bus for non-COVID reasons. Whenever such improvements are made, let the customers know about the improvements so that they are aware of the efforts.
- The performance measures that should receive the most attention after bus frequency are departure/arrival reliability and travel time (i.e., trip duration). Like bus frequency, both past and current riders believe that service reliability decreased significantly over time.
- Retain and improve weekday off-peak bus service and weekend bus service because the current riders use the bus more frequently in those periods than the riders who stopped riding the bus did when they used the bus. Of particular importance should be midday service and late evening/night service.
- Although the people who have not used the bus indicated that they would like to use the bus primarily for work/school trips and recreational/entertainment trips, when efforts are made to fulfill their travel needs, place greater emphasis on work/school trips (which are typically peak-oriented) than recreational/entertainment trips (which are typically off-peak-oriented) because the latter category of trips cannot significantly increase overall ridership due to the occasional nature of the trips.
- Recognizing that the fulfillment of the desired trips by the people who have never used the bus will require substantial expansion of bus service to currently unserved areas, consider exclusive services between selected origin-destination pairs where service is convenient and comfortable to the riders, but also charge higher fares to recover the cost-of-service expansion.
- Because many riders who stopped riding the bus indicated that they would ride the bus again if more direct buses were available to their destinations, examine the bus

network and potential origin-destination nodes to assess if more direct routes could generate sufficient ridership.

- Examine if coordination with ridehailing companies such as Uber and Lyft could increase the complementarity between the bus and ridehailing. Such complementarity may be more achievable for nighttime trips and recreational/entertainment trips.
- Because a substantial proportion of bus non-users indicated that they did not use the bus because they did not know how to get information about bus service, examine new information dissemination and marketing strategies to reach bus non-users.
- Consider technology improvements at bus stops/terminals as well onboard buses, including Wi-Fi services and real-time bus information for transfers to other buses and rail.
- Finally, with due consideration of the varying impacts of COVID-19 on different transit modes and regional travel markets because of household relocation, telecommuting, etc., examine market segmentation opportunities based on new research with the intent to grow bus ridership and overall transit ridership.

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