
Final Report

# FARE FREE PUBLIC TRANSPORTATION
# A full-scale, real-world experiment in Alexandria (VA)

Cinzia Cirillo
Department of Civil and Environmental Engineering
University of Maryland
3250 Kim Bldg., College Park, MD 20742
Tel: +1 301-405-6864 Fax: +1 301-405-2585; Email: ccirillo@umd.edu

Asal Mehdi Tabrizi
Department of Civil and Environmental Engineering
University of Maryland
3105 Kim Bldg., College Park, MD 20742
Tel: +1 301-405-6864 Fax: +1 301-405-2585; Email: asal97@umd.edu

Hesham Rakha
Center for Sustainable Mobility
Virginia Tech Transportation Institute,
3500 Transportation Research Plaza (0536), Blacksburg, VA 24061
Tel: +1 540.231.1505 | Fax: +1 540.231.1555 | Email: hrakha@vt.edu

Jianhe Du
Center for Sustainable Mobility
Virginia Tech Transportation Institute,
3500 Transportation Research Plaza (0536), Blacksburg, VA 24061
Tel: +1 540.231.2673| Fax: +1 540.231.1555 | Email: jdu@vt.edu

Date
August 2023

Prepared for the Urban Mobility & Equity Center, Morgan State University, CBEIS 327, 1700 E. Cold Spring Lane, Baltimore, MD 21251




# ACKNOWLEDGMENT

## Disclaimer

*The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the U.S. Department of Transportation's University Transportation Centers Program, in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.*

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| **4. Title and Subtitle**<br>FARE FREE PUBLIC TRANSPORTATION<br>A full-scale real-world experiment in Alexandria (VA) | | **5. Report Date**<br>August 2023 |
| | | **6. Performing Organization Code** |
| **7. Author(s)** | | **8. Performing Organization Report No.** |
| **9. Performing Organization Name and Address**<br>University of Maryland<br>College Park, MD 20742 | | **10. Work Unit No.** |
| | | **11. Contract or Grant No.**<br>69A43551747123 |
| **12. Sponsoring Agency Name and Address**<br>US Department of Transportation<br>Office of the Secretary-Research<br>UTC Program, RDT-30<br>1200 New Jersey Ave., SE<br>Washington, DC 20590 | | **13. Type of Report and Period Covered**<br>Final |
| | | **14. Sponsoring Agency Code** |

**15. Abstract**

The *Fare Free Public Transportation* (FFPT) concept is a common part of the agenda among transit agencies and state and federal policy makers. The subject is particularly important in the post-pandemic period, as transit use is slowly recovering but has not yet reached pre-pandemic ridership and market share. FFPT has been implemented in Europe and to a certain degree in the USA; however, there are very few studies that have effectively collected data and evaluated the consequences with respect to its implementation. This study monitored a full-scale, real-world FFPT plan implemented in Alexandria, VA in the Fall of 2021, separating respondents into treatment and control groups. Descriptive statistics indicated minimal disparity between the treatment and control groups across most socio-demographic variables. Notably, residents of Alexandria exhibit a higher propensity to use buses compared to the control group, both prior to and post-policy implementation. Regarding awareness of the policy, a majority of respondents were uninformed, while the policy's impact is more pronounced among those who were aware. Around 32% of respondents increased their bus usage following FFPT implementation, with approximately 80% of this subset utilizing buses more frequently than before. This policy evaluation is relevant not only to Alexandria, but to many stakeholders across the country that are considering similar policies in other cities.

| 17. Key Words: | 18. Distribution Statement |
|---|---|
| Public Transportation ridership, Free-Fare policy, modal shift, social welfare | |

| 19. Security Classif. (of this report): | 20. Security Classif. (of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 20 | |

# Table of Contents

# List of Tables



# List of Figures

# 1 Introduction

In contemporary society, the concept of sustainable mobility holds paramount significance, extending beyond mere emission reduction. It encompasses the assurance of a transportation system that is not only eco-friendly, but also secure, affordable, and accessible, ensuring an elevated quality of life and facilitating seamless journeys (Banister 2008). However, the prevailing dominance of car-centric lifestyles underscores the inherent unsustainability of this paradigm. The appeal of automobile dependency persists due to its low fixed and variable costs, coupled with its ready accessibility. Moreover, the emergence of events like the COVID-19 pandemic has further strengthened car reliance, driven by a desire for personal protection, thus augmenting the already heightened dependence on automobiles.

Yet, this growing car-centric culture carries detrimental consequences, including noise and air pollution, traffic congestion, and the fragmentation of landscapes (Pojani and Stead 2015). Moreover, this mode of transportation exacerbates inequalities as not all individuals have access to cars, leading to societal discrimination (Lucas 2012). Given these challenges, the prevailing transportation trends are clearly unsustainable in the long run. Thus, novel strategies are imperative to foster environmental sustainability and societal progress. Encouraging the use of public transportation and other eco-friendly modes of travel is a pivotal approach in this endeavor, with the implementation of free fare transport emerging as one such policy (Štraub and Jaroš 2019).

This project seeks to examine the implications of adopting the Fare-Free Public Transport policy in Alexandria during and after the COVID-19 era. The investigation will encompass an analysis of its impact on modal shifts and transit ridership, its contribution to equity and accessibility, as well as its influence on customer satisfaction. Through this comprehensive exploration, we aim to glean insights into the potential of fare-free transport to shape more sustainable and inclusive transportation systems.

# 2 Literature Review

## 2.1 FFPT definition

Fare-Free Public Transport (FFPT) is a policy that entails the elimination of fares within public transport (PT) systems. Originating in the 1960s and 1970s as a response to the escalating use of cars, this policy has been adopted in approximately 100 cities worldwide with the aim of encouraging public transportation usage (Baum 1973; Hess 2017). Various municipalities have adapted this policy to suit their specific needs and local transportation characteristics.

One such adaptation is the comprehensive implementation of FFPT on the majority of routes and services within a PT network. This approach has been embraced in Hasselt (Belgium), Templin (Germany), and Aubagne (France) (Fearnley 2013; Storchmann 2003; Van Goeverden et al. 2006). Additionally, alternative schemes include temporary FFPT, applicable during brief periods like emergencies, as observed in Stavanger (Norway) (Kębłowski 2020). Another variant is temporary-limited FFPT, which is confined to specific regular timeframes and was introduced in Milton (Canada) and Haag-Leidan (Netherlands) (Štraub and Jaroš 2019).

Spatially limited FFPT, focusing on specific sections of the PT network or modes of transport, has been implemented in locations like Haag-Leiden (Netherlands), Boston (United States), and Emeryville (United States) (Kębłowski 2020; Štraub and Jaroš 2019). Similarly, socially limited FFPT, catering exclusively to specific user groups, has been put in place in various regions such as Corvalis, Oregon (Oregon State University, USA), Logan, Utah (Utah State University, USA), and Scotland (United Kingdom) (Štraub and Jaroš 2019).

Beyond the diverse forms of FFPT adopted by municipalities to address the unique needs, characteristics, and objectives of specific cities, the motivations and goals driving the utilization of FFPT also exhibit variation. These motivations can be grouped into distinct categories. Primarily, environmental objectives take precedence. These include alleviating traffic congestion, curbing air and noise pollution, and diminishing reliance on automobiles by fostering a transition from cars to public transportation (Cats, Susilo, and Reimal 2017). In addition, the literature also reflects an array of social goals. This encompasses the augmentation of mobility, the establishment of a more equitable transportation system, the mitigation of traffic accidents, and

the enhancement of overall quality of life. This is achieved by furnishing improved access to employment opportunities, essential services, and recreational activities, thereby creating a more inclusive and accessible urban environment (Volinski 2012).

Complementing these aspirations are the economic considerations that underpin the adoption of FFPT. The economic advantages associated with FFPT are manifold, encompassing reductions in the costs of production, collection, and the entire accounting system of tickets. Particularly in smaller cities or transport systems, these benefits can yield resources that can be redirected towards the operation of FFPT, further reinforcing its viability (Van Goeverden et al. 2006).

## 2.2 FFPT pros and cons

FFPT, despite its global adoption, remains a highly contentious policy due to its wide range of advantages and drawbacks. It carries certain deficiencies concerning its utility, efficiency, and impact on economic growth (Storchmann 2003). One notable downside is its potential to strain public transportation networks financially by promoting financially unproductive mobility (Baum 1973). FFPT's implementation tends to decrease fare-generated revenue while simultaneously driving up costs linked to maintenance, security, and heightened demand from passengers. From this perspective, FFPT is most likely to be successful within smaller public transport systems, where both ticketing revenue and passenger demand are relatively modest (Fearnley 2013).

Another key criticism aimed at FFPT revolves around its limited ability to prompt a significant shift from private vehicles to public transportation (Cats, Reimal, and Susilo 2014; Cats et al. 2017). In certain cases, particularly in the United States, even though this policy has led to a ridership surge of 20% to 60%, only a modest 5% to 30% of this increase can be attributed to a transition from private cars, as noted by (Volinski 2012). The predominant share of modal shifts prompted by FFPT involves individuals who already cycled, walked, or previously utilized public transportation (Kębłowski 2020).

Apart from the criticisms directed at FFPT, it garners support from a diverse array of historians, sociologists, and academic researchers (Kębłowski 2020). Their stance posits that FFPT not only yields operational cost savings, promotes a modest shift from cars to public

transportation, and alleviates the externalities associated with car traffic, but also contributes to a broader social and political transformation. In terms of financial advantages, FFPT holds the potential to augment local budget revenue by facilitating an increase in local taxes, as exemplified in the case of Tallinn, Estonia (Kębłowski et al. 2019).

Furthermore, FFPT could foster modal shifts by enabling faster boarding, reducing dwell times, and achieving higher commercial speeds (Volinski 2012). Contrary to criticism that suggests these modal shifts primarily pertain to walking and cycling, some studies indicate that in certain programs, this policy can indeed result in a reduction in car usage (Brown, Hess, and Shoup 2003).

The interplay of these pros, cons, and conflicting findings underscores the complexity of the FFPT debate, demonstrating that the effectiveness and impacts of this policy are context-dependent and multifaceted.

## 2.3 Covid-19 implication

The implications of COVID-19 have introduced a complex dynamic to the realm of public transportation (PT). Fearing the potential transmission of the virus on PT vehicles, there has been a notable shift towards personal automobiles, which are perceived as a safer mode of travel from an epidemiological standpoint (Adey et al. 2021; Basu and Ferreira 2021). This shift poses a significant challenge, potentially prolonging the return to pre-pandemic levels of ridership. However, it's worth noting that there is limited evidence to support disease transmission via PT (Howland et al. 2020; Schwartz 2020).

In response to the pandemic, PT agencies have taken measures to instill confidence in their services. This includes investing in the thorough sanitation and cleaning of their fleets, along with the provision of free personal protective equipment (Goldberg 2021). Additionally, a noteworthy response has been the abolishment of fare collection by most PT agencies in the US, thereby offering Fare-Free Public Transport (FFPT) to encourage usage and address concerns related to both health and economic constraints.

Prior to the COVID-19 pandemic, the implementation of Fare-Free Public Transport (FFPT) in the United States was prevalent in three distinct types of localities: college towns, tourist resort

areas, and small urban or rural communities (Kębłowski et al. 2019). However, in certain locations such as Kansas City, Missouri; Thurston County, Washington; and Alexandria City, Virginia, FFPT had not been put into effect until the onset of the pandemic (Goldberg 2021).

Exploring the implementations of FFPT by different agencies during the COVID-19 period reveals a nuanced landscape. While the policy aspires to foster equitable access to public transportation, providing justice and usage opportunities for diverse groups of people, its tangible contribution to this concept varies across agencies. Additionally, the effectiveness of FFPT diverges among these agencies, underscoring the intricate interplay of local circumstances and contexts (Goldberg 2021).

Indeed, as highlighted earlier, Fare-Free Public Transport (FFPT) manifests in diverse forms and serves varying goals across different societies. The contentious discourse surrounding its advantages and drawbacks in different localities, each characterized by unique transit dynamics, emphasizes that findings from previous studies cannot be simply extrapolated from one location to another. This underscores the need for context-specific analyses.

Furthermore, the dearth of comprehensive studies evaluating the effectiveness of FFPT implementation during the COVID-19 pandemic, specifically in terms of its impact on commoning public transportation mobility, enhancing accessibility, and promoting equity, accentuates the necessity for insights derived directly from real-world, localized, and full-scale FFPT implementations. Such data would offer a clearer understanding of FFPT's implications in the face of evolving challenges, contributing to a more informed approach to policy formulation and decision-making.

# 3 Data Collection

## 3.1 The Survey

### 3.1.1 The Survey Questionnaire

The survey questionnaire is comprised of FILL sections. The first elicits information about the number of motor vehicles available to the respondent’s household, and the specifics of the

vehicle the respondent used most often, including make, model, model-year, fuel economy and miles driven in the last 12 months.

The next section inquired about the use of different types of private and public transportation. How often did the respondent use, in descending order, their own motor vehicles, the bus, Metro rail, taxis or Uber, or a bicycle in the last month? How often did they walk to their destinations? We offered five possible response options ranging from "daily" to "never." We then asked the respondent the same questions, but for August 2021 (just before the free bus policy in Alexandria). If the respondent indicated a change in their use of public transportation since the previous year, we further inquired about the reasons for such a change.

Section 3 asked respondents whether they were aware of fare discounts or the availability of free surface or underground public transportation where they live. Residents of Alexandria were then informed that bus rides had been free of charge in their city since September 2021 and asked to indicate if and how they had changed their transportation patterns as a result. Residents of other areas where the buses are generally not free were then asked what they would do if bus rides became free. We anticipated that in some cases people living at our control locations might mistakenly say that bus rides are free in their area, in which case we asked if and how their travel patterns had changed as a result.

Section 4 of the questionnaire is a one-day trip diary similar to that used in the National Personal Transportation Survey or in Regional Travel Survey. Section 5 is limited to people that have used the bus in the previous four weeks and asks basic information about their most recent bus ride. Section 6 gathers socio-demographic information and concludes.

### 3.1.2 Survey Administration

The survey questionnaire was programmed in Qualtrics and administered to a total of 997 respondents recruited from the Qualtrics panel in Alexandria (N=338), Washington, DC, and the counties in the DC metro area directly abutting Washington, DC (N=659). We imposed the requirement that the sample be comprised of an even number of men and women, and be stratified for income, with 25% of the respondents in each quartile of the distribution of household income in the area. In the 12 counties and cities covered by the survey, the first

quartile of household income was, at the time of the survey, $55,000; the second was 100,000, and the third $165,000.

### 3.2 The Traffic Count Data

In order to analyze the variations in local traffic patterns following the implementation of the free bus system, we obtained traffic count data from the Virginia Department of Transportation. Our data request encompasses all the local roads depicted in Figure 1, given that the local buses exclusively operate on these routes.

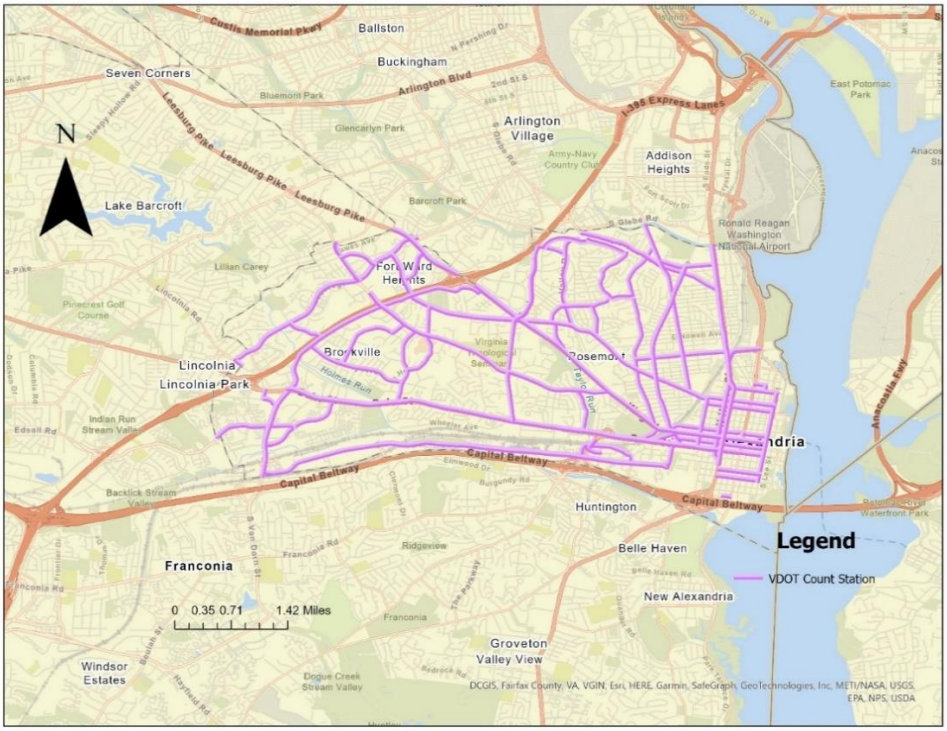


**Figure 1** Road segments with traffic counts in between 2018-2021

## 4 Descriptive Statistics of The Data

### 4.1 The Survey

We obtained a total of 997 completed questionnaires from 338 subjects in the treatment location and 659 at the other locations (see Table 1). Since Frederick Co. never discontinued the free ride policy it adopted at the beginning of the pandemic, we consider our true control group to be

comprised of 615 persons (659 minus the 44 residents of Frederick). Our respondents completed the questionnaire between June 24, 2022, and July 5, 2022.

**Table 1** Composition of the sample by location. Alexandria = Treatment location; all other locations except Frederick: Control locations.

| location | N | % |
|---|---|---|
| Alexandria | 338 | 33.9 |
| Arlington County | 45 | 4.51 |
| Calvert County | 19 | 1.91 |
| Charles County | 20 | 2.01 |
| City of Falls Church | 9 | 0.9 |
| Fairfax County | 109 | 10.93 |
| Frederick County | 44 | 4.41 |
| Manassas | 12 | 1.2 |
| Manassas Park | 4 | 0.4 |
| Montgomery County | 134 | 13.44 |
| Prince George's County | 85 | 8.53 |
| Prince William County | 58 | 5.82 |
| Washington DC | 120 | 12.04 |

Summary statistics about the sociodemographic characteristics of the sample are displayed in Table 2. Some 17.15% of the respondents consider themselves Hispanic. The composition of the sample by race is displayed in table 2. Whites/Caucasians account for over 60% of the sample, African Americans for some 20%, and Asians for just under 8%. Native Americans and Hawaiians/Pacific Islanders account for just under 4%. There are no statistically significant differences across the treatment and control locations in terms of the shares of the various races.

**Table 2** Composition of the sample by race. Percent of the sample.

| | control locations | Alexandria | t test |
|---|---|---|---|
| American Indian and Native Alaskan | 1.67 | 4.14 | -0.37547 |
| Asian | 7.89 | 7.1 | 0.122693 |
| Black/African American | 21.7 | 19.53 | 0.363215 |
| Multiracial | 1.52 | 1.18 | 0.051187 |
| Native Hawaiian and Pacific Islander | 0.76 | 1.78 | -0.15338 |
| Other | 3.79 | 5.62 | -0.2807 |

| | | | |
|---|---|---|---|
| White/Caucasian | 62.67 | 60.65 | 0.485565 |

Compared to the control locations, our Alexandria sample boasts a larger share of the full-time and part-time employed respondents (88% v. 66%) (Table 3). The educational attainment of the respondent is similar across Alexandria and the control locations, however, with t tests indicating that the shares of schooling level are not statistically different (Table 4). This is clearly a highly educated sample, with more than half of the respondents in each group having a four-year college degree, a master's degree or a PhD, or a professional degree. This sample is similar to ASC results, which shows that more than half of the people in this area have bachelor's and graduate or professional degrees.

**Table 3** Composition of the sample by employment status. Percent of the sample.

| | FT or PT employed | homemaker, students, or retired | other | total |
|---|---|---|---|---|
| Alexandria | 88.17 | 11.54 | 0.30 | 100 |
| Control locations | 66.02 | 29.59 | 4.39 | 100 |

**Table 4** Share of the sample by educational attainment.

| | control locations | Alexandria | t test |
|---|---|---|---|
| Less than high school | 0.0179 | 0.003 | 0.22 |
| High school graduate | 0.1724 | 0.1686 | 0.06 |
| Some college | 0.2016 | 0.1716 | 0.50 |
| 2-year degree | 0.0829 | 0.0976 | -0.23 |
| 4-year degree | 0.2618 | 0.2544 | 0.13 |
| Post-graduate education | 0.2098 | 0.2337 | -0.40 |
| Professional degree | 0.0537 | 0.0710 | -0.26 |

Both the treatment and control group mirror the area's household income quartiles (Table 5).

**Table 5** Distribution of the sample into the area's household income quartiles.

| Income quartile | control locations | Alexandria |
|---|---|---|
| 1 | 24.55% | 25.74% |
| 2 | 24.23% | 26.92% |
| 3 | 26.83% | 21.89% |
| 4 | 24.39% | 25.44% |

Table 6 reports the percentages of the Alexandria and control location samples that use the bus on a daily basis, 3-5 times a week, 1-2 times a week, occasionally, and never. The table shows that Alexandria residents are more likely to take the bus and were more likely to take the bus than residents at the control locations—both before and almost a year after the implementation of the free bus policy.

**Table 6** Usage of transit before and with the free bus program. Percentage of the treatment and control groups.

| | | Daily | 3-5 times a week | 1-2 times a week | Occasionally | Never |
|---|---|---|---|---|---|---|
| Alexandria | Before | 6.8% | 14.2% | 16.9% | 26.9% | 35.2% |
| | After | 8.0% | 17.5% | 16.0% | 23.7% | 34.9% |
| Control | Before | 5.0% | 5.9% | 10.7% | 16.4% | 62.0% |
| | After | 5.2% | 8.8% | 9.3% | 20.0% | 56.7% |

The figures in table 4 suggest very small changes in the shares of the respondents who take the bus with any frequency in the year since the beginning of the policy. At control locations, the number of respondents who "never" take the bus has fallen by about 5%, and that of persons that take the bus 1-2 times a week has fallen by 1.4%. These persons appear to have moved to the "occasional" and "more than 1-2 times a week" categories, making a very small individual impact on each of these categories. Among the residents of Alexandria, there has been a small decline in the shares of users that take the bus "never," only "occasionally" or 1-2 times a week, and a small increase in the shares of daily (1.2%) and 3-5 times a week (3.2%) users. These increases are not statistically significant at the conventional levels when taken individually.

### 4.1.1 Do People Know about the Free Bus Program?

We posit that respondents have correct knowledge of DASH's free bus program if they say that free bus rides are available to everyone in their area. In Alexandria, 73.67% of the respondents are not correctly informed about the free bus rides. Based on the results of DID model, the effect

of the program is 5% to 9% higher among respondents who are aware of the policy, but the effect is not statistically significant in two cases out of three.

When asked what they did since the inception of the free bus program, 108 (31.95%) of our Alexandria respondents said that they took the bus more often, 24.56% said they actually used the bus less often, an equal number (53) said that they took Metrorail more or less often, 24% said that they used their car more often, 13% said that they used the car less often, and 25% said that they had not changed their habits at all. These categories are not mutually exclusive, and it was possible for the respondents to select more than one response category.

We checked the survey responses of the 108 people who said that since the introduction of free bus rides they had been riding the bus more often. For almost 80% of them (79.62%, to be precise) the reported frequency of bus use in the previous month is indeed greater or equal to that reported in August 2021.

## 4.2 The Traffic Count Data

The count stations located on local roads are not permanent fixtures; instead, they are typically temporary installations that remain in place for 6-48 hours, depending on the specific objectives of data collection. This duration may vary depending on whether the data collection is part of routine monitoring or a roadway improvement project, and these temporary stations are typically set up every 2-5 years. Ideally, we aimed to gather data immediately before the implementation of fare-free buses (prior to September 2021) and immediately after that period for each count station. However, the data obtained from the Virginia Department of Transportation (VDOT) are unbalanced in terms of both duration and time period.

The data were collected at different stations and during different time periods, resulting in an absence of counts available both before and after the fare-free bus implementation at any given station. For instance, certain stations have counts from before September 2021, along with older data collected in 2018, while others have data collected after September 2021, along with older data collected in 2019. Furthermore, the COVID-19 pandemic presented an additional challenge in identifying traffic patterns. The traffic patterns experienced significant changes in 2020-2021 due to COVID-19-related factors such as shelter-in-place orders (Du 2020; Du et al.

2021; Du and Rakha 2022). It is imperative to account for this interference in the data analysis. Additionally, traffic volumes naturally fluctuate over time due to factors such as the number of registered vehicles, economic conditions, traffic improvement projects, and changes in travel behavior.

To establish a comparative framework capable of accommodating the disturbances caused by COVID-19 and accounting for normal traffic fluctuations, we implemented a data filtering process. We selected all count stations with at least 24 hours of available data in both the year 2021 and 2018. These stations were then divided into two groups: Group 1 consisted of stations with counts available in both 2018 and 2021 before the fare-free bus system was implemented, while Group 2 comprised stations with counts available in both 2018 and 2021 after the fare-free bus system was implemented. The objective was to identify changes in traffic volumes between these two groups and determine if the changes were consistent. The resulting numbers of count stations were 30 stations (each with 2 directions) for Group 1 (before the fare-free buses) and 62 stations (each with 2 directions) for Group 2 (after the fare-free buses). We calculated the daily traffic counts for each station and plotted the two groups against each other. Figure 2 demonstrates that the trend lines for the 2018 versus 2021 counts before the fare-free buses and the 2018 versus 2021 counts after the fare-free buses are closely aligned, suggesting similar changes at these stations. A two-sample T-test comparing the two groups yielded a p-value of 0.26, indicating that the test does not reject the null hypothesis that the two groups follow the same distribution.

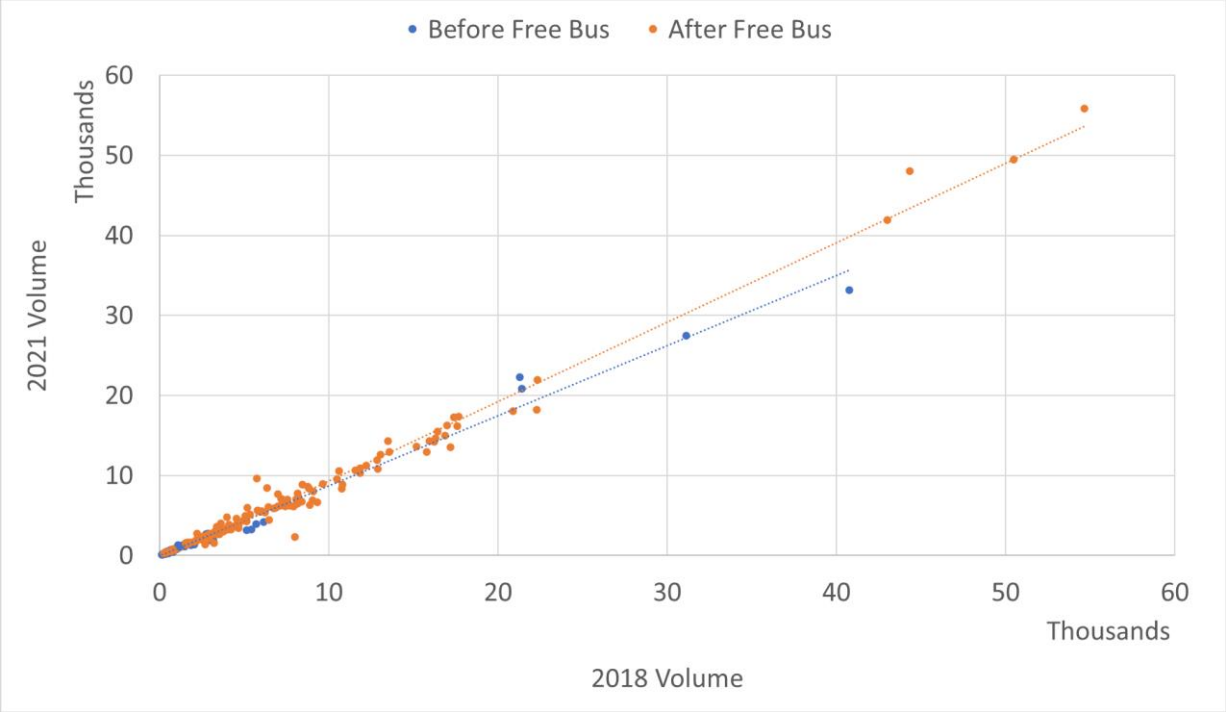


**Figure 2** Traffic counts comparison

# 5 Conclusion

This project endeavored to gain insight regarding the public response toward the fare-free public transport (FFPT) policy through a meticulously designed survey. This survey encompasses respondents' socio-demographic details, their daily trip information, and their pre- and post-policy public transportation usage. Conducted in Alexandria, Washington, DC, and neighboring counties within the DC metro area where FFPT is implemented, the survey segregates respondents into treatment and control groups. Descriptive statistics show that there is minimal variation in most socio-demographic variables between the treatment and control groups. Notably, residents of Alexandria exhibit a higher propensity to use buses compared to the control group, both before and after policy implementation.

Regarding awareness of the policy, a majority of respondents were uninformed, while the policy's impact is more pronounced among those who were aware. Around 32% of respondents

increased their bus usage following FFPT implementation, with approximately 80% of this subset utilizing buses more frequently than before.

In addition to the survey, traffic count data for roads serviced by local buses was utilized. Both pre- and post-FFPT traffic count data sets exhibit similar distributions, suggesting comparable changes.

In the future work, a second wave of data will be analyzed, paving the way for forthcoming explorations. These forthcoming endeavors will encompass a more detailed analysis of the second wave and a comprehensive investigation into FFPT's influence on modal shifts, equity, accessibility, and customer satisfaction.

# 6 References


Adey, Peter, Kevin Hannam, Mimi Sheller, and David Tyfield. 2021. *Pandemic (Im) Mobilities*. Vol. 16. Taylor & Francis.

Banister, David. 2008. "The Sustainable Mobility Paradigm." *Transport Policy* 15(2):73–80.

Basu, Rounaq, and Joseph Ferreira. 2021. "Sustainable Mobility in Auto-Dominated Metro Boston: Challenges and Opportunities Post-COVID-19." *Transport Policy* 103:197–210.

Baum, Herbert J. 1973. "Free Public Transport." *Journal of Transport Economics and Policy* 3–19.

Brown, Jeffrey, Daniel Baldwin Hess, and Donald Shoup. 2003. "Fare-Free Public Transit at Universities: An Evaluation." *Journal of Planning Education and Research* 23(1):69–82.

Cats, Oded, Triin Reimal, and Yusak Susilo. 2014. "Public Transport Pricing Policy: Empirical Evidence from a Fare-Free Scheme in Tallinn, Estonia." *Transportation Research Record* 2415(1):89–96.

Cats, Oded, Yusak O. Susilo, and Triin Reimal. 2017. "The Prospects of Fare-Free Public Transport: Evidence from Tallinn." *Transportation* 44:1083–1104.

Du, Jianhe. 2020. "COVID-19 Impact on Ride-Hailing: The Chicago Case Study." *Transport Findings*. doi: 10.32866/001c.17838.

Du, Jianhe, and Hesham Rakha. 2022. "Bikeshare Interactions with Other Transportation Modes During the COVID Pandemic."

Du, Jianhe, Hesham A. Rakha, Fethi Filali, and Hoda Eldardiry. 2021. "COVID-19 Pandemic Impacts on Traffic System Delay, Fuel Consumption and Emissions." *International Journal of Transportation Science and Technology* 10(2):184–96. doi: https://doi.org/10.1016/j.ijtst.2020.11.003.

Fearnley, Nils. 2013. "Free Fares Policies: Impact on Public Transport Mode Share and Other Transport Policy Goals."

Goldberg, Dori. 2021. “The New Geography of Fare-Free Public Transport: Examining the Suspension of Fares in the United States During COVID-19.” *Brussels: Master in Urban Studies (ULB/VUB)*.

Hess, Daniel Baldwin. 2017. “Decrypting Fare-Free Public Transport in Tallinn, Estonia.” *Case Studies on Transport Policy* 5(4):690–98.

Howland, Renata E., Nicholas R. Cowan, Scarlett S. Wang, Mitchell L. Moss, and Sherry Glied. 2020. “Public Transportation and Transmission of Viral Respiratory Disease: Evidence from Influenza Deaths in 121 Cities in the United States.” *PLoS One* 15(12):e0242990.

Kębłowski, Wojciech. 2020. “Why (Not) Abolish Fares? Exploring the Global Geography of Fare-Free Public Transport.” *Transportation* 47(6):2807–35.

Kębłowski, Wojciech, Tauri Tuvikene, Tarmo Pikner, and Jussi S. Jauhiainen. 2019. “Towards an Urban Political Geography of Transport: Unpacking the Political and Scalar Dynamics of Fare-Free Public Transport in Tallinn, Estonia.” *Environment and Planning C: Politics and Space* 37(6):967–84.

Lucas, Karen. 2012. “Transport and Social Exclusion: Where Are We Now?” *Transport Policy* 20:105–13.

Pojani, Dorina, and Dominic Stead. 2015. “Sustainable Urban Transport in the Developing World: Beyond Megacities.” *Sustainability* 7(6):7784–7805.

Schwartz, Sam. 2020. “Public Transit and COVID-19 Pandemic: Global Research and Best Practices.”

Storchmann, Karl. 2003. “Externalities by Automobiles and Fare-Free Transit in Germany—a Paradigm Shift?” *Journal of Public Transportation* 6(4):89–105.

Štraub, Daniel, and Václav Jaroš. 2019. “Free Fare Policy as a Tool for Sustainable Development of Public Transport Services.” *Human Geographies* 13(1):45–59.

Van Goeverden, Cees, Piet Rietveld, Jorine Koelemeijer, and Paul Peeters. 2006. “Subsidies in Public Transport.”

Volinski, Joel. 2012. *Implementation and Outcomes of Fare-Free Transit Systems*. Transportation Research Board.