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Micromobility in Rockville

The fate of Rockville has always been closely tied to its transportation infrastructure and the ways it has both connected and divided people. As a neighbor of the nation's capital, it acts as both a home and a through-way to thousands of federal workers. The same railroad that connects residents to DC has also been used to partition the city, physically isolating communities from resources and economic opportunities.

In response to these challenges, the city planning department has received a grant to assess the area surrounding the Twinbrook Metro Station with the goal of installing a footbridge spanning the railway. This initiative is part of a broader effort to implement transit-oriented developments (TOD) in Twinbrook. To finance these projects, city planners are seeking additional funding from the Department of Transportation and the Washington Metropolitan Area Transit Authority (WMATA). Specifically, they are applying for the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant Program, which supports transportation infrastructure projects that serve areas of persistent poverty and/or historically disadvantaged communities.

A crucial aspect of the city’s planning strategy is micromobility — specifically, public personal mobility vehicles such as shared bicycles. Rockville’s city planners are interested in understanding how such trends may develop locally. To meet the eligibility criteria for federal grants, the city is investigating how micromobility can be better integrated into transit infrastructure in Rockville’s transportation ecosystem.

To support this initiative, I have assessed how people have utilized shared bicycles in the region, particularly focusing on public data from Capital Bikeshare, which maintains over 5,000 bikes across the DMV. By assessing how these bikes have been used in D.C., and North Bethesda (a past recipient of the RAISE Grant), I aimed to forecast how their usage might evolve in Rockville as the system becomes more established.

I used a traffic stress survey conducted by the Montgomery City Planning Department to evaluate patterns in ridership in the context of biking infrastructure. In addition, I assessed the commuting habits of residents with data from the 2023 American Community Survey.

A graph of a graph

AI-generated content may be incorrect.A graph with a number of trips

AI-generated content may be incorrect.The scope of my research was limited by the processing abilities of R. Capital Bikeshare posts trip data for the DMV monthly. I first intended to aggregate four years trip data, but this compiled a dataset of over 19 million observations. This really limited my ability to process the data in R, especially after converting it into geospatial data. By limiting the research scope to Montgomery County, I was able to reduce the dataset down to about 302,000 observations.

Since the focus of my project is on Twinbrook Metro Station as a multi-modal transit hub, I wanted to characterize trips by whether they were within a half-mile radius of a metro station. This half-mile metric is used within the transportation industry; a half-mile is equivalent to a 5-to-10-minute walk.

A screenshot of a graph

AI-generated content may be incorrect.I conducted a T-test comparing the number of trips that were initiated near a metro against those that started far from one and found that they were significantly different from each other. I followed this up with another T-test, this time comparing trips with destinations near a metro to those far from one. These groups were also significantly different from each other. There are more trips that start and end near a metro station than those that start/end far from one. This could be because pedestrians congregate around metro stations and people may be incorporating bikes in their travel plans as a first- or last-mile part of their journey.

After these results, I wanted to understand if these groups also differ in their characteristics. Trips that end near a station have a lower average duration than trips that end far from one.

Trips near metro stations show a sharp peak at 4-6 minutes and taper off more quickly, while those started far from a metro station have a broader distribution, indicating greater variability in travel times. The most frequent trip duration from metro-adjacent origins is between 3 and 7 minutes, reinforcing the finding that metro access leads to shorter trips.

Looking deeper into the interaction between metro proximity and trip duration, these histograms are organized to illustrate the durations of trips that begin near a station in the first column and end near a station in the first row.

Trips that begin and end near a metro station show the highest frequency and shortest duration, typically between 3 and 5 minutes. Trips that start or end far from a metro station, or both, have longer durations, often ranging from 5 to 10 minutes. These patterns support the idea that metro-proximate trips are generally shorter, likely due to the convenience of nearby infrastructure or first/last-mile connections.

Given the evidence that the characteristics of bike trips that start/end within a metro catchment area are different than those that start/end far from one, I wanted to compare the intra-buffer variation in trip frequency. How does the frequency of bike trips differ between stations?

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AI-generated content may be incorrect.Calculating the average annual number of trips per station, we find that the Bethesda and Silver Spring metro stations have the highest ridership counts among the thirteen stations studied here, with ridership surpassing 6,000 and 7,000 bike trips respectively. The lowest ridership counts are observed at Glenmont, Grosvenor-Strathmore, and Forest Glen metro stations, with average bike trip counts of 10, 30.7, and 97.8, respectively.

North Bethesda, formerly known as White Flint, metro station, has the third highest bike ridership count, with average annual counts over 2,000. We wanted to pay attention to what's happening at the North Bethesda metro station since they were past recipients of the RAISE Grant that the city planners seek to apply for on the behalf of Twinbrook Metro station (with over 900 average annual bike trips).

It is interesting how adjacent metro stations could be so variable in their ridership counts. Friendship Heights and Takoma metro stations are on the border of DC and Maryland, but their trip numbers are surpassed by Bethesda and Silver Spring. In addition, those two metro stations are neighbors to stations with particularly low ridership, like Forest Glen and Medical Center (4th lowest ridership count, at approximately 700 average annual bike trips). Since there was no obvious geospatial patterns in annual ridership, I wanted to A screenshot of a computer screen

AI-generated content may be incorrect.investigate whether the presence or absence of biking infrastructure impacted trip counts.

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The Montgomery County Planning Department surveyed streets within the county to evaluate the Levels of Traffic Stress (LTS) for bikes. They characterized stress according to traffic speed, traffic volume, number of lanes, frequency of parking turnover, ease of intersection crossings and others. For streets within a metro's half-mile radius, I calculated the proportion of street length designated as high stress to those that are low stress.

A graph of a line graph

AI-generated content may be incorrect.In this scatterplot, I compare the total number of trips initiated near each station to the proportion of streets with high traffic stress within a metro's radius, I found that there was no significant correlation observed between these two variables. The results of a Pearson's correlation test, estimate t = -0.0347, with a p-value = 0.973. Even when removing the two outliers at the top of the scatterplot, t = 1.20, with p-value = 0.261.

A screenshot of a computer screen

AI-generated content may be incorrect.Without evidence to prove a significant spatial relationship, I move towards other patterns. The following is a density histogram of trips by start date and time, and it illustrates a distinct seasonal pattern. Ridership peaks each year during the summer and drops during the winter months. This trend is consistent from 2020 through late 2024, with 2024 showing the highest density peaks across the entire period. The data indicates growing adoption and a predictable cyclical rhythm aligned with weather and commuting habits.

Having investigated the 'where' and 'when', I wanted to explore the 'who'. The following choropleth illustrates the proportion of the residential population that commutes to work by car. The darker blue areas along the metro line suggest that residents in these census A screenshot of a map

AI-generated content may be incorrect.block-groups utilize other transit strategies, like metro, public transportation, or some other means. According to the American Community Survey for 2023, there was a very low density of people who commuted to work on bikes exclusively. However, this does not discount the potential role of bikes in the lives of residents. The survey asks for their dominant form of transportation to work, and bikes may be included in multi-modal transit strategies. This survey also excludes the habits of residents outside of their work-commute.

The capital bikeshare data identifies which of their trips were taken by members (people with a Capital Bikeshare subscription) vs casual, one-time riders. This boxplot shows casual users have a slightly higher median trip count than members, but also greater variability. According to a T-test, the average weekly total of trips by casual riders is 468, compared to 416 for members. They differ significantly with a p-value = 0.0084. The wider distribution and higher number of outliers among casual users suggest more fluctuation in ridership, likely linked to tourism, weather, or occasional use cases.

A graph with red and blue lines

AI-generated content may be incorrect.A screenshot of a graph

AI-generated content may be incorrect.Noting the high number of outliers in the number of trips by casual riders, I decided to look into this variation more deeply. This graph shows monthly trip counts from 2020 to 2025 for both casual users and members. Initially, casual users outpaced members, but starting in 2024, the two groups converged and peaked simultaneously with an all-time high of almost 5,000 trips. Notably, member trips remained elevated through winter, whereas casual trips dipped sharply. This contrast illustrates member consistency and hints at bikeshare's evolution from a seasonal leisure tool to a year-round commuting option.

I followed this up by comparing the intra-station variation in seasonality and change over time. The faceted line plots each show the number of trips originating from each of the metro stations by month and year. Stations like Bethesda, Silver Spring, and White Flint display consistently high ridership across all years. Twinbrook's line trends steadily upward each year, especially during summer months. In contrast, some stations like Grosvenor-Strathmore show minimal or stagnant trip numbers. This visual suggests varying degrees of bikeshare integration across the network and helps isolate Twinbrook as a site of sustained, incremental growth. A screenshot of a graph

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A graph of different colored bars

AI-generated content may be incorrect.This bar chart displays the growth rate of the annual number of trips originating from various metro stations across three years: 2022 (red), 2023 (green), and 2024 (blue). The Y-axis represents the relative growth rate compared to the previous year. Glenmont and Forest Glen showed the most substantial growth spikes, particularly in 2023 for Glenmont and in 2024 for Forest Glen, suggesting these areas are rapidly increasing in usage. Grosvenor-Strathmore had a significant decline in 2022 but recovered in the following years, while Friendship Heights and White Flint showed negative growth in one or more years, indicating volatility in trip demand. Takoma and Silver Spring exhibited consistent positive growth, pointing to steady increases in ridership. Bethesda, despite having high average trips from earlier Tukey HSD results, shows minimal year-to-year growth, suggesting it may have reached a saturation point. Several stations such as Rockville, Twinbrook, and Wheaton showed moderate to flat growth trends, possibly indicating stable but unspectacular demand.

I wanted to end this presentation with the most recent data available from City Bikeshare (or at least was at the time I started this project), and compare the number of trips per station for the month of February from 2021 to 2025. While some stations have yet to catch up with their trip frequency from last year, 2025 ridership is already expected to surpass their 2024 numbers at most stations.

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