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GIS 5577

Comparing bike and scooter share usage in Minneapolis, MN

**Introduction**

Micromobility has become increasingly popular worldwide in recent years (Galatoulas et al. 2020, Oeschger et al. 2020). Its ability to solve the first and last mile transportation holds promise for an integrated transport system with multiple economic, social, and environmental benefits (APTA 2021, Oeschger et al 2020). Micromobility can be defined as “the use of micro-vehicles: vehicles with a mass of no more than 350 kg(771 lbs) and a design speed no higher than 45 km/h (ITF 2020). Examples of micro-vehicles are bikes and electric scooters.

In Minneapolis Minnesota bike-sharing and e-scooters have gained popularity. In 2018, Minneapolis launched a scooter share pilot with 2500 scooters available for use and has continued this program since. Scooters utilize the same rules as for bikes; scooters must be operated in bike lanes or with traffic and parked and locked at racks or nearby signposts (City of Minneapolis 2020). Unlike bikes, scooters are electrically powered and must be recharged. However, both micro-vehicles require infrastructure like bike lanes for routes and their cost for usage is similar.

This study aims to compare the usage of bike and e-scooters. Specifically, are bike sharing and scooter sharing complimentary or competing with one another based on their usage and travel patterns. Furthermore, because micromobility increases accessibility, this study will also examine the demographics (race and median income) of where trips are occurring to infer who may be using the micro-vehicles most and compare end trips to existing bus transit stops.

**Database description**

The conceptual database has a table for nice ride stations which is connected to the nice-ride-trips-2018 table through the station id. The Minneapolis streets are a shapefile joined to the escooter-2018 table spatially. The e-scooter after being given geometry will be spatially joined to the mn-tracts. The nice ride station table is joined to the nice ride trips by station id. The latitude and longitude for start and ends are set as the geometry and spatially joined to the mn-tracts. The demographic tables, race and median-hh-income are joined to mn-tracts based on the geo\_id and geoid.

**Data, types, and sources**

*Obtaining datasets*

The 2018 nice ride dataset was obtained from Nice Ride. The 2018 scooter dataset, Minneapolis road centerlines and Minneapolis city boundary were obtained from the City of Minneapolis. The demographic data for median household income and race on the census tract level was obtained from IPUMS NHGIS from the ACS 2014-2018 survey dataset.

**Methods**

*Preprocessing datasets*

The preprocessing steps were performed using python. For the e-scooter dataset, a trip ID was computed by combining the dataset year with the trip ID that was in the dataset to begin with. This is to allow future datasets to be added. Through observation, the 2019 dataset had repetitive trip ID records which can be problematic in the future since this was not truly unique, thus a new primary key was computed.

For the nice ride bike share data, the primary key was the trip ID and the trip ID was computed by combining the record’s bike ID, and the start time stamp. Like the e-scooter dataset, there was not a unique trip ID present in the nice ride bike share dataset. By extracting the integers from the timestamp combined with the bike’s ID, this method was used to compute a unique ID suitable for future records as well.

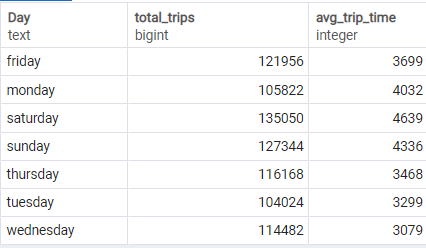


Table 1. 2018 Nice ride bike share activity summary for each weekday. Trips were categorized by which day they occurred on and the average trip time was calculated using SQL.

The demographic data from the ACS was cleaned by removing empty columns and renaming the column names to be more understandable. The geo\_id was also cleaned to remove extra zeroes so the tabular data could be joined to the census tracts geometry. The primary key was the geo\_id.

**Data analysis**

*Micromobility usage*

To compare the usage in both e-scooters and bikes, various statistics and metrics were calculated. The total trip count, average trip duration, average trip distance, start and end date range, total activity per month. The usage per hour of each weekday was computed by first identifying the day of the week for each trip, extracting the hour for each trip, then grouping by the weekday concatenated with the hour. This computed the overall total trips that occurred for each weekday (Monday through Sunday) for each hour of the day. I then normalized these counts by dividing them by the total trips that occurred on the specified weekday. For example, through this method I am getting the percent of activity occurring on Mondays for each hour instead of percentage of trips occurring on Mondays at 1:00 p.m.

*Start and end hotspots, and proximity to transit stops*

Each dataset had different location start and end types. The e-scooter dataset has locations correspond to road centerlines. The nice ride bikes have locations as coordinates corresponding to docks or dockless points. A view was created for each start and end locations for both datasets in the database to be used later in QGIS and to be able to update over time on-the-fly as data is added. This allows for hotspots to always be identified as records are added.

To observe the proximity of starting and ending locations to transit stops, the transit stops were buffered 0.25 miles or 402.336 meters. This distance was chosen because most transit stops are designed to be within a fourth of mile walking distance. The road centerlines were then intersected with the buffers and the percent of starting and ending trips falling in those buffers were calculated. The final statistic was percentage of total trips that started and ended within ¼ of a mile of transit stops.

*Social demographics*

The ACS survey demographic datasets containing race and median household income metrics were joined to the census tracts. The percentage of non-white for each census tract was calculated by this formula: ((total population - white alone)/total population )\*100. Then using QGIS, the data was symbolized with a natural breaks classification with five classes to show demographics within Minneapolis. Observations were then made about the possible correlations by comparing the demographic maps to the maps for the start and end hotspots for each micro vehicle type.

**Results**

*Nice ride and e-scooter usage*

The nice ride and e-scooter usage was compared initially by computing multiple statistics and summarizing metrics. The dataset for the Nice Ride bike share dataset for 2018 ranged from April 2018 to November 2018. There was a total of 824,846 trips with an average trip time of 3825 seconds. This averages about 117,835 trips per month. The month with the most bike share trips was July, and the least was November. The date with the most trip was in July. In comparison, the e-scooter dataset for 2018 ranged from July 2018 to December 2018. There was a total of 225,543 trips with an average trip time of 1127 seconds and average trip distance of 2157 meters. The month with the most e-scooter trip activity was October and the least was December. The date with the most trips was in October.

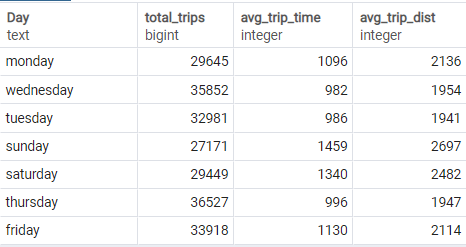


Table 2. 2018 E-scooter bike share activity summary for each weekday. Trips were categorized by which day they occurred on and the average trip time was calculated using SQL.

In terms of usage during weekdays, the most nice-ride trips occurred on Saturdays and these trips also had the longest average trip duration. The weekday with the least number of trips overall was Tuesday (fig 1). In comparison, most nice ride trips occurred on Thursdays and the longest trip durations were on Sundays. The day with the least number of e-scooter trips was Sunday (fig 2).

Examining all trips on an hourly level for each weekday, the activity percentage trend for each weekday is similar. Each weekday had a peak hour and showed more activity in the morning. The peak activity for each weekday is between 8:00-8:59 AM for both micro-vehicles and the peaks are similar throughout the weekdays (fig 1). Throughout the day, the activity decreased after the peak with lower hourly activity after 4 pm.

E-scooter and bikeshare trips were similar in their start and ending locations. The areas with the most starting and trips for both micro-vehicles appear to be downtown Minneapolis and the University of Minnesota campus (fig 2, 3). Also, locations for ending trips of both micro-vehicles compared to the starting trip locations appear to be dispersed throughout the City – shown through the increase of points and road centerlines with trip counts (fig 2, 3). ­

*Proximity to Transit Stops*

The percentage of trips within a 0.25 buffer of a transit stop for e-scooters was 100% and 93.85 for the nice-ride bikes.

*Demographics*

Median household income and percent non-white were observed for each census tract in Minneapolis. The tracts with the highest median household income appear to be in the south west of the city boundary and the lowest median household income tracts are in downtown and north of downtown Minneapolis. For percent non-white, the areas with higher non-white populations were in tracts of downtown and north of downtown Minneapolis, while the tracts with a lower non-white population were in the southern region and north east corner of Minneapolis (fig 4).

Chart

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*Figure 1. Percentage total activity for each hour of each weekday. Activity was calculated by dividing the total count of trips occurring on the respected hour of the weekday by the total trip counts occurring on that weekday. The e-scooter and nice ride data were collected in 2018 within the city of Minneapolis, MN.*

­ **Discussion**

The usage counts for the nice ride bikes and the e-scooters are different. Nice ride bikes have a higher count and a larger average trip duration. The usage activity in terms of total counts for each weekday for scooters have the most on usage on Thursdays and for nice ride bikes it is Saturday. When examining the activity on an hourly level for each weekday, both micro-vehicles have a similar trend throughout each weekday. The start and end locations are similar for both as they have highest trip counts for start and end locations in the downtown Minneapolis area and the University of Minnesota Minneapolis campus (fig 2, 3). The demographics of the tracts where the most trips start and end for each micro-vehicle correspond with low median household income rates and high non-white population (fig 4).

The usage of both micro-vehicles does not appear to compete with one another. The differences in trips counts could be attributed to the number of bodies for each vehicle. The nice ride bikes share program launched much earlier than the scooter and may have more availability in general. Furthermore, there is already infrastructure such as docks for bikes which can hold more than 5 bikes while scooters are dockless, and they are typically found at corners of blocks. Additionally, when the activities are examined on an hourly level for each weekday, the pattern of activity is very similar. When there is a peak in usage for the nice ride bikes, there is a similar increase in the e-scooter usage (fig 1). This suggests that folks are not favoring one micro-vehicle over another. Instead, they are both being used similarly in the same locations.

The start and end locations of the bikes and e-scooters are very similar. It suggests users are traveling from and within the downtown and University of Minneapolis campus mostly. With typical city traffic and presence of students in these areas, the micro-vehicles are a great alternative to the typical city bus and helps users decrease on wait times for traveling. One observation about the ending locations for the nice rides bikes is the ending points may be outside of the Minneapolis boundary, suggesting that users are traveling further than users using the e scooters. This is also indicated by the average trip duration time. Most trips started and ended within 0.25 miles Euclidean distance of a transit stop. There are many transits stops in Minneapolis especially in the areas where the most e-scooter and bike share trips occurred. One way to improve the observation of users to transit stops is using a network instead of a Euclidean distance to determine the 0.25 buffer. However, because of the density of transit stops, it showed that most or all trips occurred within the buffer.

The people living in the areas where the most trips are starting and ending had lower median household income and a higher non-white population (fig 4). This implies that micromobility is helping folks of lower household income and of color to travel around the city. Of course, the areas where trips are occurring also coincides with high population density like the downtown area of Minneapolis and the UMN college campus.

Overall micromobility has many benefits. The usage of the two micro-vehicles is similar and have similar starting and ending locations. The folks living in the tracts where the trips start, and end imply that there are some social benefits in helping folks with lower income and of color travel throughout the city. Further studies can incorporate a smaller scale like block groups, network analysis, and collected demographics of the micro-vehicle users to observe the effectiveness of micromobility in Minneapolis, MN.

**Challenges and problems**

Overall, I found databases to be quite powerful. It was able to perform spatial intersection operation and calculations without needing to open software like ArcGIS Pro. The biggest struggle I had overall was loading the data in and making sure I had a primary key. My initial idea was to analyze more than one year of data. However, upon trial and error, I found that the trip ids in the datasets were repetitive. I did not use the database to calculate the trip id, however if I were to, I would have inserted a new column with the concatenation and formatted strings and set that as the primary key.

Another issue I had was with using the shp2pgsql GUI to load in shapefiles. I found it hard to be selective on which columns I wanted to keep and remove. I ended up using python as well to prepare the data for being loaded in. Lastly one thing I could see databases struggling with is the evolution of the data schema. I noticed in 2019 and 2020 that there were new columns, and some columns were reorganized or renamed in a slightly different case. This makes it slightly more difficult to add more data into the database.

**Solutions that databases provide**

I think databases organizes data in a way where it can grow or how we can expect it to grow. It also performs analysis without having to use another software. It provides speed in its ability to query without altering the data quickly. The queries output the metrics I wanted to calculate without using multiple tools. One feature I really find useful is the views. I could see this being useful for using the same data in different mapping scenarios – like if I wanted to remove personal information for a public facing map. The advantage is I would not necessarily have to create a new dataset, but instead filter what I do not want to be seen. Lastly, I think the ability to connect the views or queries with software like QGIS is useful because it makes visualization of the queries easy. Overall spatial databases has many capabilities like other software, but provide flexibility through the queries, views, and data types.

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*Figure 2. E-scooter starting and ending locations corresponding to road centerlines in Minneapolis MN for the year 2018. The total counts of trips were calculated for each road centerline based on their starting and ending locations. Areas with most total trip counts are downtown Minneapolis and the University of Minneapolis campus.*

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*Figure 3. Nice ride bike share starting and ending locations corresponding to dock stations or dockless coordinates in Minneapolis MN for the year 2018. The total counts of trips were calculated for starting and ending locations. Areas with most total trip counts are downtown Minneapolis and the University of Minneapolis campus.*

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*Figure 4. Demographic metrics for each tract intersecting with the Minneapolis boundary. The metrics observed were median household income and non-white percentage for the population. The areas with the lowest median household income are in downtown Minneapolis and north of downtown Minneapolis. The highest median income tracts are in the south west of Minneapolis. For the percent non-white, the southern region of Minneapolis has the lowest percent non-white and the highest are in downtown and north of downtown Minneapolis.*

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