

Introduction

The aim of this report is to provide a high level overview of how BIXI customers use their bikes, what factors may influence usage at different times of the day and/or year, and to provide insights and information related to station popularity and their surrounding areas. The goal is to provide a general overview of business growth and what can be done to grow BIXI's memberships and revenue.

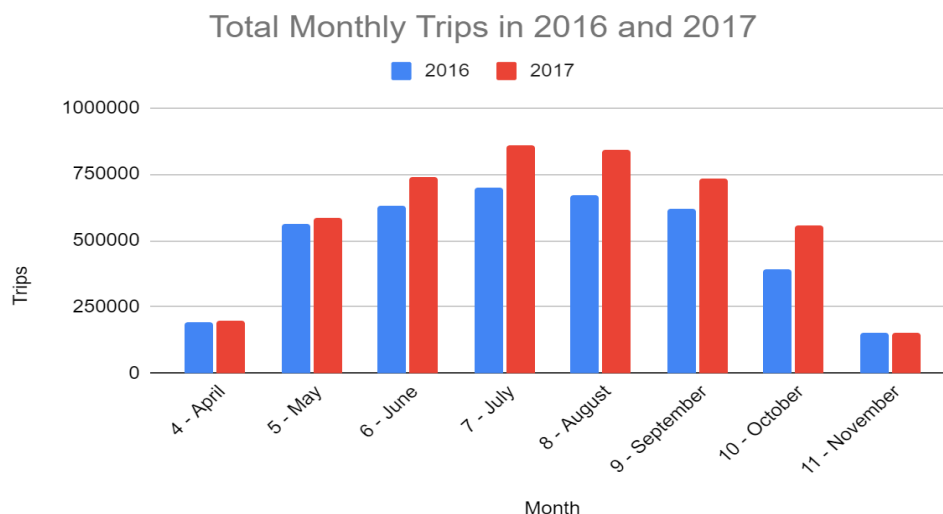
Description of Variables of Interest

In this report, the variables that will be discussed most will be related to the time of year, time of day, membership status, station popularity, and lastly, any external factors that may influence the number of trips observed throughout the year.

Analysis & Data Visualizations

To begin my analysis, I compared the number of trips taken in 2016 to the number of trips taken in 2017. From 2016 to 2017, the total number of trips taken increased by 749,364, or just over 19%. This tells us that BIXI certainly experienced growth as a business in just one year, as well as growth in popularity as a method of transportation for Montreal residents. To dive deeper into the data, I broke down BIXI's trips by month and compared the monthly trips by year.

Figure 1: Monthly trips in 2016 and 2017

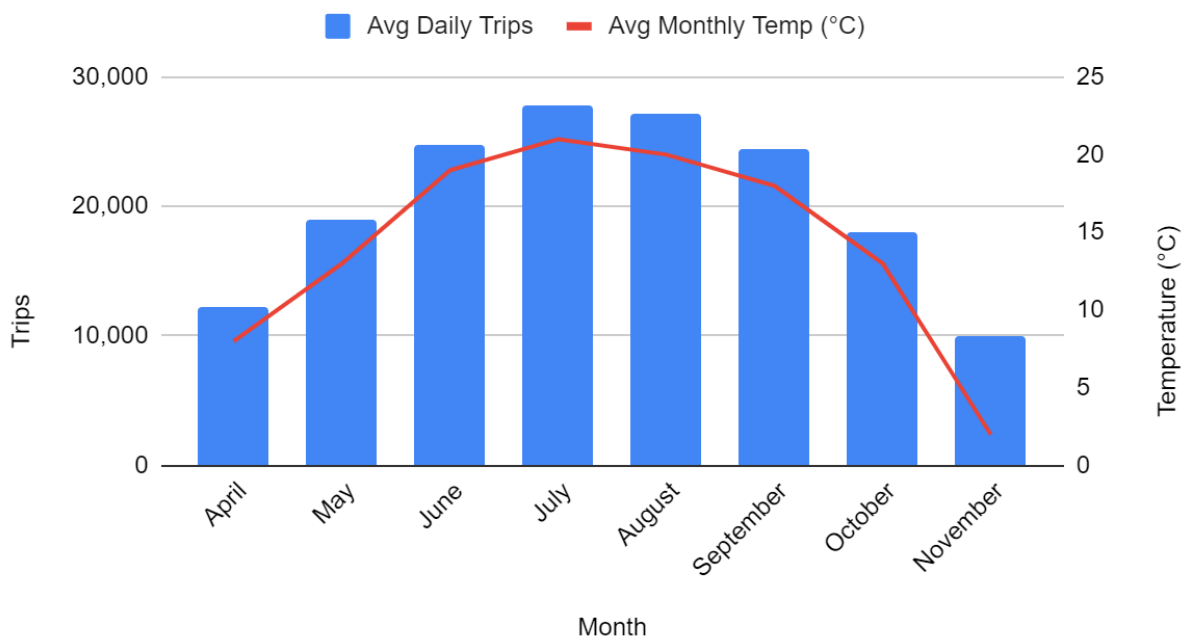


It can be observed that July and August saw the highest volume of usage in 2016 and 2017. The data also presented the fact that April and November experienced the lowest number of monthly trips in both 2016 and 2017.

According to TimeAndDate.com, April and November had the coldest average temperatures in the dataset in both 2016 and 2017, and as expected, July and August had the warmest average temperatures in both years. When we look at the average daily trips in 2017 broken down by month, and the average monthly temperatures in Montreal in 2017, we can see in Figure 2 that there is a positive relationship between the weather and the usage of BIXI bikes.

Figure 2: Average monthly temperatures and average daily trips by month¹

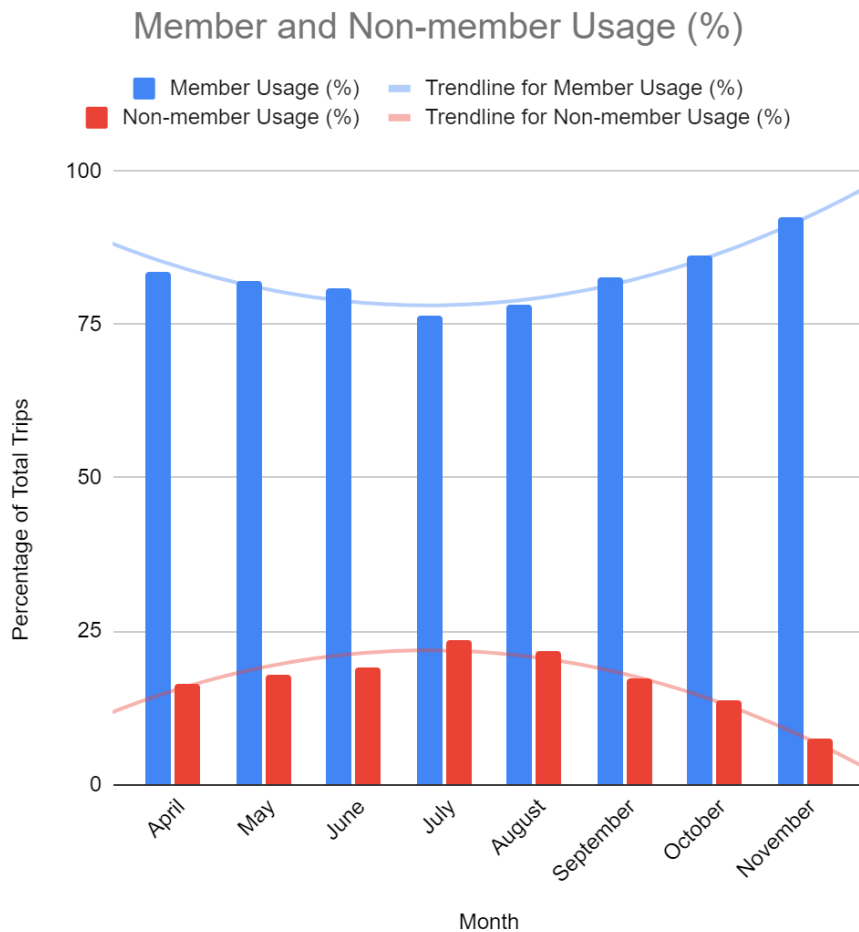
Average Daily Trips & Average Temperatures by Month in 2017



After further exploration and analysis of the data, I noticed that while overall demand for BIXI bikes increased in 2017 as average temperatures rose, and overall demand decreased as average temperatures fell, the percentage of trips taken by members relative to non-members fell as overall demand increased, and rose as overall demand fell.

¹Source for monthly average temperature data: <https://www.timeanddate.com/>

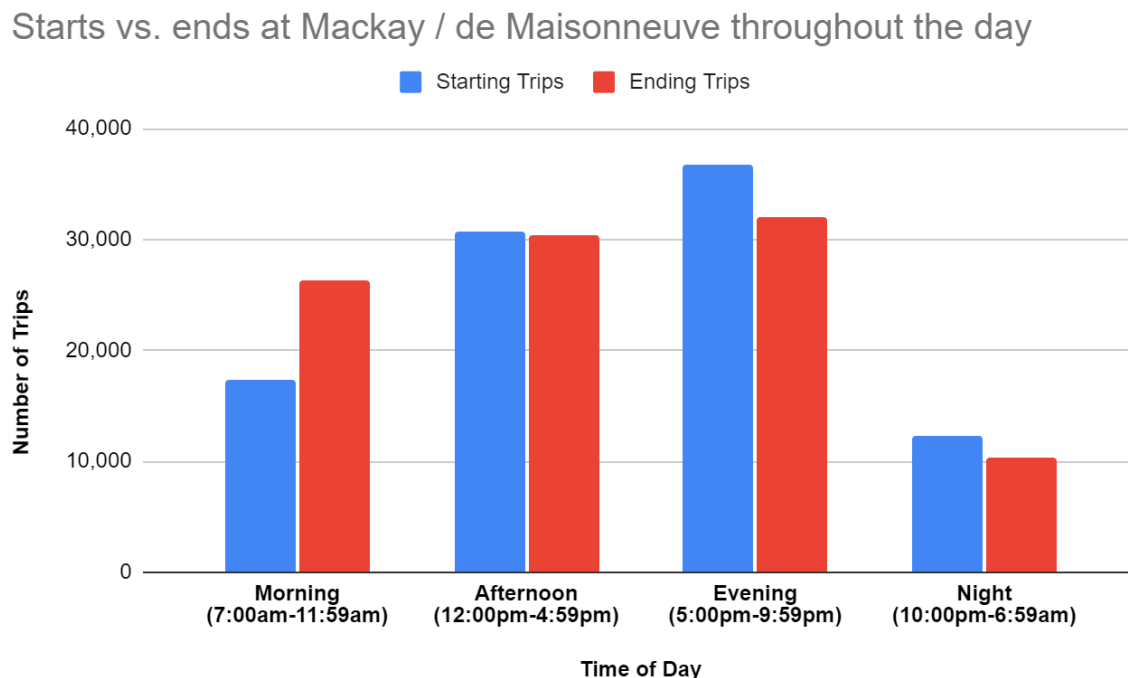
Figure 3: Member vs. non-member usage as a percentage of monthly trips in 2017



With usage among non-members increasing in the summer months, and peaking in July and August, there may be an opportunity for BIXI to convert some of its non-members to members. While some of the increase in non-member usage can be explained by tourists traveling to Montreal during the summer months, tourists would only be attributed to part of the increase; this leaves us with the opportunity to convert non-member users who are residents of Montreal. If BIXI were to offer a special promotion to its non-member customers in June, and make it a condition of the promotion that the offer must be claimed by the end of June, just before non-member demand jumps by roughly 4.4 percentage points, this could lead to an increase in BIXI memberships. This could also lead to an increase in overall usage for the rest of the year, as members tend to use BIXI bikes more consistently throughout the year, potentially mitigating part of the 4.5 percentage point decrease we see from August to September among non-member users.

To gain a better understanding of usage across the city of Montreal and to explore what factors may impact usage at specific stations, I analyzed the data further hoping to determine whether the time of day or any other factors were associated with the popularity of stations. When defining station popularity in terms of the number of trips starting at each station, I found that Mackay / de Maisonneuve topped the list, followed by Metro Mont-Royal, and Metro Place-des-Arts. I reviewed whether usage at the busiest station, Mackay, varied throughout the day, and then compared whether there was a noticeable difference between trips that started at Mackay station versus trips that ended there throughout the day.

Figure 4: Starts vs. ends at Mackay / de Maisonneuve throughout the day



As we can see in Figure 4, usage throughout the day for starts and ends at Mackay station are similar in terms of what times are relatively busier than others. After reviewing the timing of trips and the station's location within the city, particularly its proximity to many businesses, offices, subway stations, and what seems to be equally important, its proximity to a university, it appears the station's location and the surrounding area's demographic in terms of occupation (i.e. student or working professional) can both be attributed to the pattern we see in Figure 4.

Generally speaking, students are likely to use a bike as a means of transportation, which could help explain why the top three most popular stations are in close proximity to a university. The number of trips taking place in the evening can be explained by the high student population as well, as we would expect that students would have the most free time in the evenings.

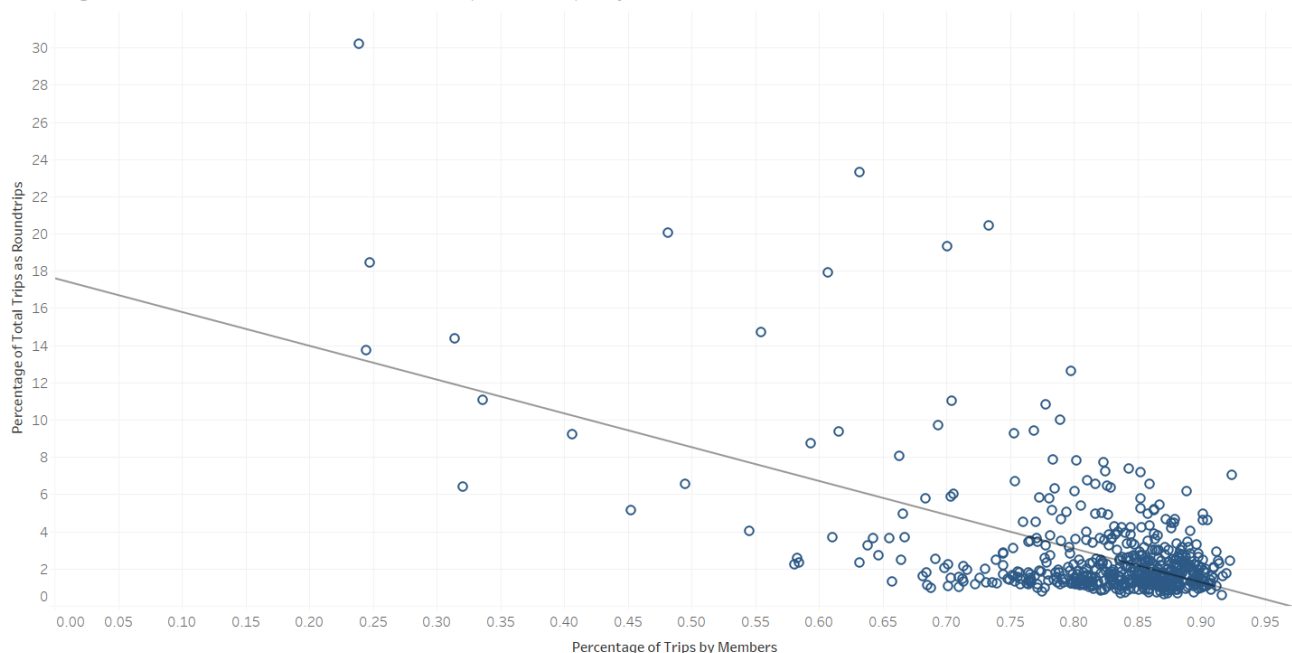
Additionally, office workers typically work between 9:00am and 5:00pm, and the professionals working in the area would contribute to the high number of trips starting in the evening as their commutes to return home would be taking place sometime after 5:00pm. The fact that the top three busiest starting points are located within walking distance to universities/colleges, subway stations, and workplaces, further supports the notion that the density of students and working professionals in a station's neighborhood has an impact on that station's usage patterns and popularity.

To further investigate the relationship between usage and location, I looked at the trips that started and ended at the same station (i.e. roundtrips). I found that there were only 15 stations with at least 10% of their trips as roundtrips, and I noticed that most of these stations were located in areas in close proximity to tourist attractions, public outdoor areas, and recreational facilities (e.g. parks, lakeside areas, beaches, theme parks, islands, etc.). These 15 stations also happened to be located in areas with fewer stations overall. The frequency, or infrequency, of roundtrips at a given station can likely be explained by the area and demographic once more.

To learn more about how BIXI's members use their bikes, I explored whether there was a relationship between membership status and frequency of roundtrips at the station level.

Figure 5: The relationship between roundtrips and membership status at the station level

The Negative Correlation Between Roundtrips and Trips by Members



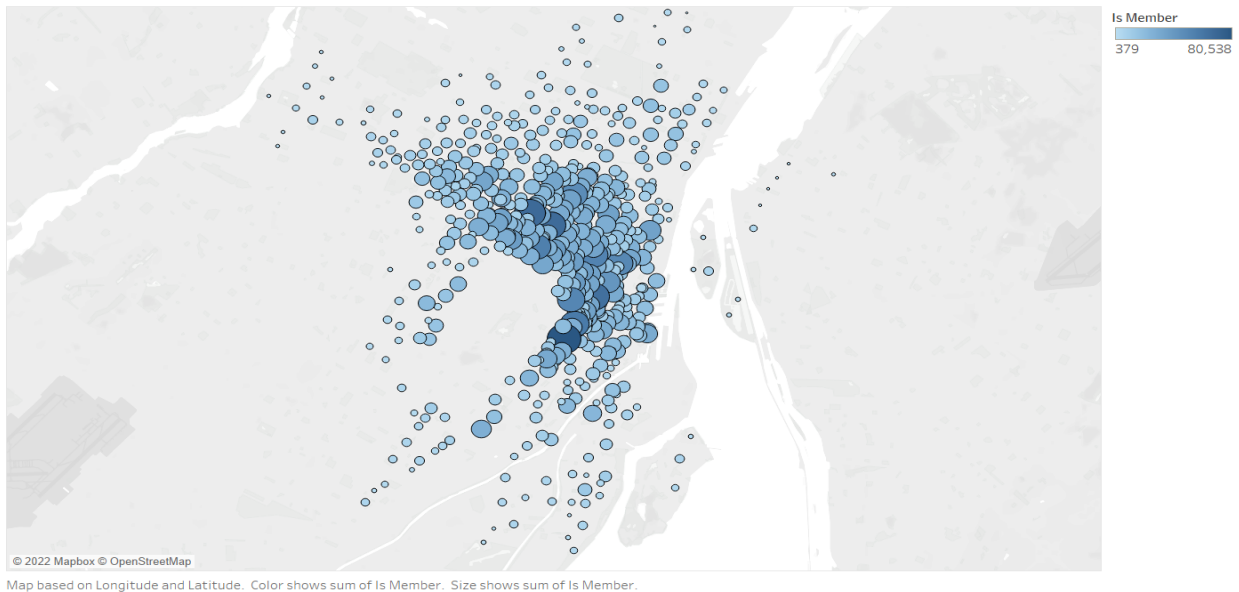
Percentage of Trips by Members vs. Percentage_Roundtrips. Color shows details about Name.

When looking at Figure 5, we can see that there is a negative correlation between the percentage of trips by members and the percentage of roundtrips at the station level. The trend line we see in Figure 5 suggests that almost 32% of the variation in the percentage of roundtrips can be explained by the percentage of trips taken by members at the station level. This suggests that when we see a station with a high membership base, we will likely see a fall in roundtrip usage, and conversely, when we see that a station has a high frequency of roundtrips, we will likely see a fall in the number of trips by members. Finally, since we know that stations with a higher frequency of roundtrips tend to be in neighborhoods with fewer stations overall, the relationship we see in Figure 5 supports the notion that the number of stations in a neighborhood is positively related with usage among members.

To gain a better understanding of how members use BIXI bikes across the city, I opted to visualize member usage and trip duration across all stations. In Figures 6 and 7 below, we will see the number of member trips across the city of Montreal and the average duration of trips across the city of Montreal respectively.

Figure 6: Member usage across the city of Montreal

Member Usage Across Montreal

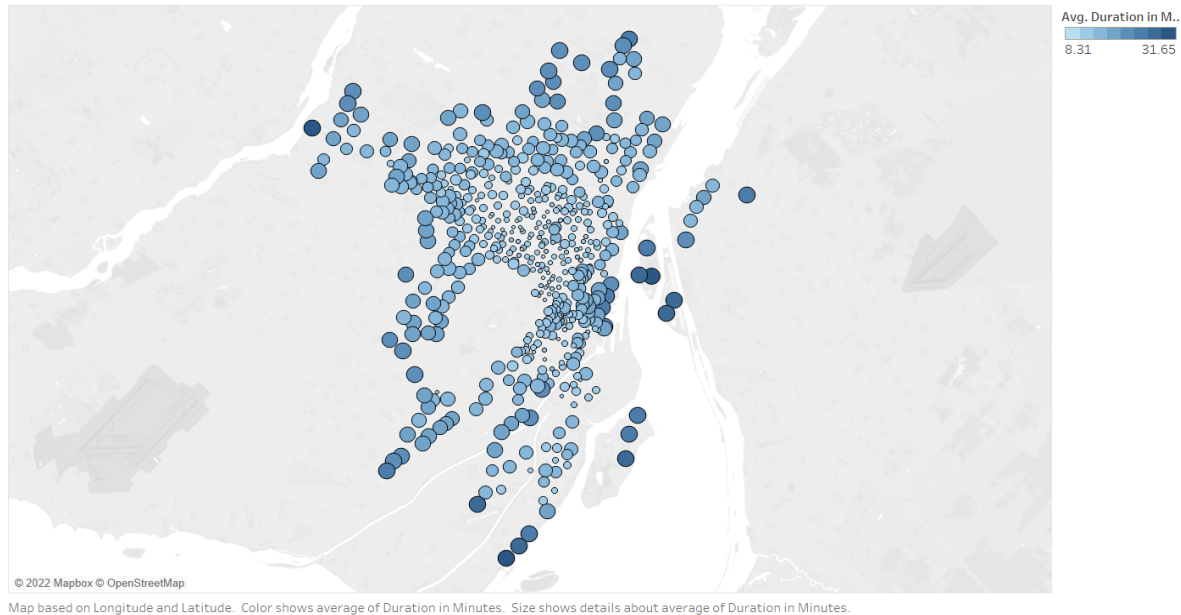


In Figure 6, we have member usage represented in two ways; by color and size. We can see that the size and tone of the marks representing stations are both larger and darker (indicating high member usage) in downtown Montreal, where we know most universities, colleges, and offices are located, and where we'd see the highest density of residents. This tells us that the downtown area (and areas with a higher density of residents overall) experience more frequent

usage by members. We will now take a look at whether member usage may have a relationship with the average duration of trips across the city.

Figure 7: Average duration of trips (in minutes) across the city of Montreal

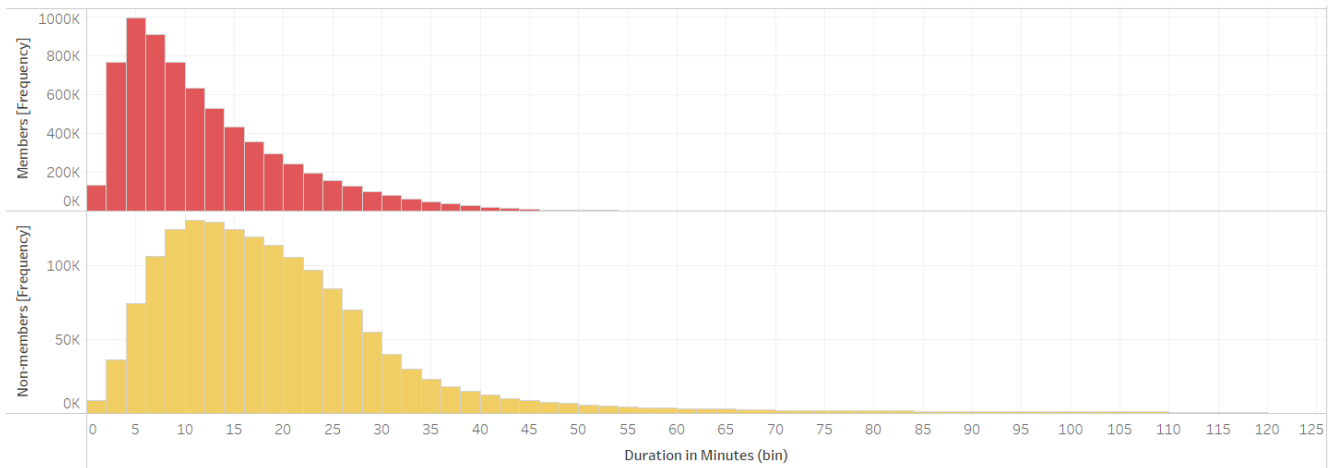
Average Duration of Trips Across Montreal



In Figure 7, we have the average duration of trips (in minutes) across stations represented in two ways; by color and by size. The larger the size of the mark, and the darker the color of the mark, the longer the average trip duration is for that station. As we can see in Figure 7, the average duration of trips increases as we leave the downtown core. If we were to look at Figure 6 and Figure 7 side by side, we would see that there is a negative relationship between the average duration of trips and member usage across stations. We now have a clear understanding that the duration of trips, the frequency of roundtrips, and usage by members are all related to one another, and can help explain differences in usage across stations and membership status. We will now review how non-members use bikes in comparison to members.

Figure 8: Distribution of Member Trips vs. Non-member Trips by Duration

Distribution of Member Trips vs. Non-members Trips by Duration



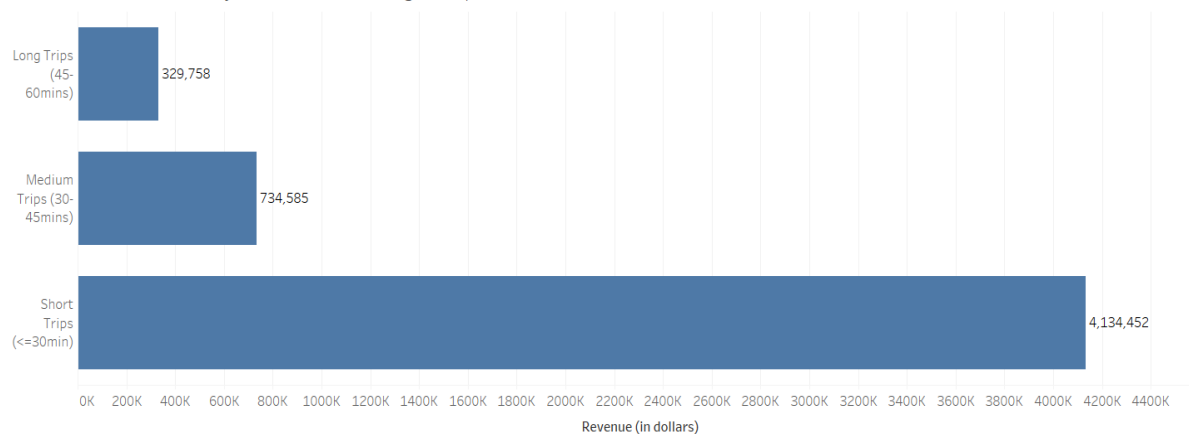
The trends of count of Duration in Minutes, sum of Is Member and Non-members for Duration in Minutes (bin).

In Figure 8 we can see the difference in the distribution of members vs. non-member trips by duration. In particular, we see that the frequency of non-member trips rises slower relative to member trips as duration increases from 0 to 5 minutes, however the frequency of non-member trips remains elevated for longer durations in comparison to member trips. We can also see that members most frequently ride for roughly 5 to 6 minutes, where non-members most frequently ride for 11 to 12 minutes. This allows us to conclude that non-members typically enjoy longer rides than their member counterparts.

Lastly, I will review the revenue associated with non-member trips by duration (with short trips up to 30 minutes, medium trips between 30 and 45 minutes, and long trips 45 to 60 minutes).

Figure 9: Revenue Generated by Non-member Trips²

Revenue Generated by Non-Member Single Trips

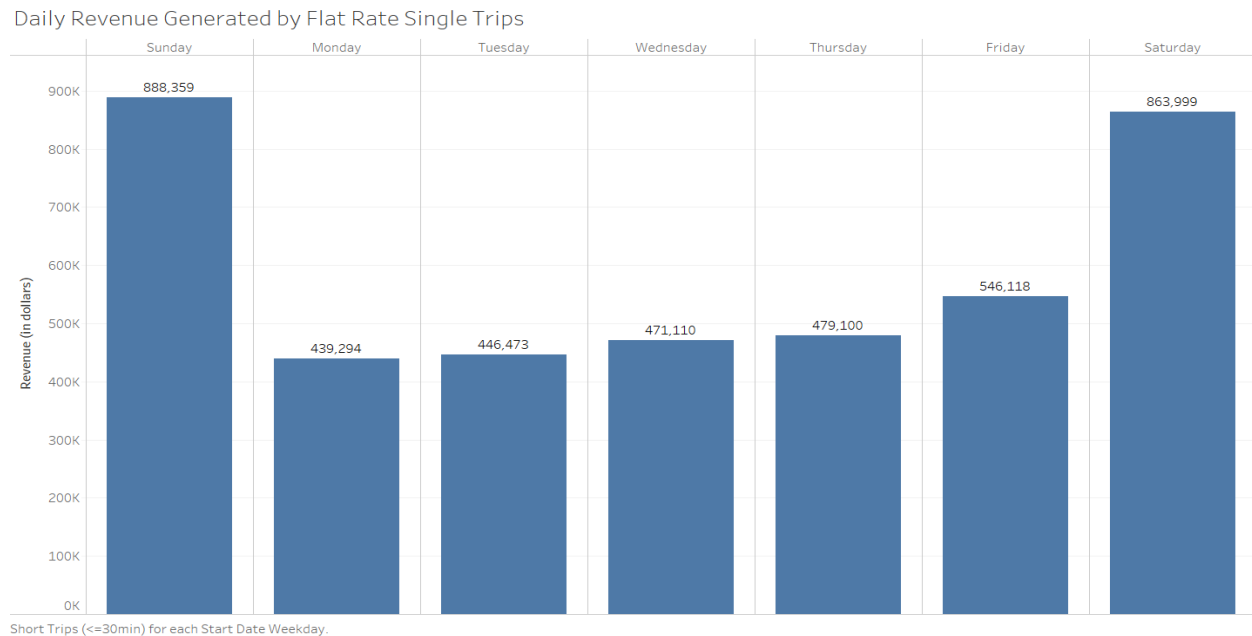


Long Trips (45-60mins), Medium Trips (30-45mins) and Short Trips (<=30min).

² Revenue estimates are based on the assumption that all non-member trips are single trips and are based on the following pricing structure: \$2.99 for each trip that is 30 minutes or less, \$4.79 (\$2.99 + \$1.80) for trips greater than 30 minutes up to 45 minutes, and \$7.79 (\$2.99 + \$1.80 + \$3) for trips greater than 45 minutes up to 60 minutes in length.

Although we now know that non-member single trips are frequently longer than member trips, we can still observe that trips with durations of 30 minutes or less generate the most revenue (refer to Figure 9). In fact, short trips account for nearly 80% of all revenue associated with single non-member trips. To get a better understanding of usage at this level, we will briefly explore daily revenues associated with short trips.

Figure 10: Revenue from short non-member trips broken down by day



In Figure 10, we can better understand total daily revenue generated by single trips with durations equal to or below 30 minutes. We can clearly see that Sundays generate the most revenue, followed closely by Saturdays. As expected, weekends are the most popular days among non-members, who would most likely be those using BIXI bikes for leisure, exercise, or touring around the city. I also reviewed revenue generated for each hour of each day and noticed that the hour between 5:00pm and 6:00pm generates the most revenue Monday through Friday among non-member short trips. This should not come as a surprise as most individuals work between the hours of 9:00am and 5:00pm, and therefore this likely captures the afternoon rush hour crowd that *sometimes* uses BIXI as a method of transportation for their afternoon commute. It is important to recall that there is an opportunity for BIXI to convert some of the non-member riders using their bikes, particularly for those using their services during the week for their commute to or from work.

Conclusions & Insights

BIXI experienced a substantial increase in growth from 2016 to 2017. Based on the data and relationships between usage and different factors found in this report, I would encourage BIXI to consider the presence of post-secondary educational institutions, subway stations, offices and other workplaces in an area, its population density, as well as the presence of tourist attractions and recreational facilities when looking into expanding their business and opening new stations across the city. BIXI should also pay close attention to the impact the number of stations in a given area may have on usage patterns.

While non-members tend to take longer trips, shorter trips equal to or below 30 minutes in length generate the most revenue, and over the two years included in the dataset, weekends were the most popular days among non-members. While non-members certainly use BIXI's bikes most frequently on the weekends, there are still a large number of non-member riders using their bikes during the work week, specifically for their afternoon commute. I would therefore recommend that in the month prior to peak demand, BIXI should look into offering a special promotion to their non-member users that would make their trips more cost effective if they became a member. Since members tend to use BIXI bikes more consistently throughout the year, this would likely lead to an increase in total trips and revenue throughout the year, therefore leading to overall growth for the company.