"Weather" to Rent a Bike

HANNA HAUSMANN
WISCONSIN SCHOOL OF BUSINESS
DECEMBER 2021

Executive Summary

PhillyCycle is a bicycle sharing company based in Philadelphia that has grown tremendously during its years of operation. Customers have the choice of casually renting bikes from PhillyCycle through a one-time pay station fee or by obtaining a monthly membership and receiving reduced prices. Since starting operation in 2010, PhillyCycle has been a success and hopes to expand operations to further increase profits.

The company has given us data from a range of customers within the past two years in hopes of gaining insights on important trends and areas of improvement. Our team cleaned the data by removing all duplicates, as well as adding additional columns in order to analyze even more variables. With our analytical expertise and plethora of customer data, we identified several ways to expand operations in the future to see greater successes from PhillyCycle.

Current demand trends in Philadelphia show that peak rental times are during morning and evening commuting hours, and these rentals are from registered users. Additionally, the number of rentals is highest when temperatures are highest. To meet these demands, PhillyCycle should closely monitor these variables and stock more bicycles at stations during morning and evening commuting times, and when temperatures are expected to be high. The positive correlation between temperature and rentals can also guide PhillyCycle in selecting which cities to expand company operations to. A few of our suggestions include Las Vegas, Phoenix, Denver, and Salt Lake City, as these cities are also low in humidity, which is a statistically significant variable shown to decrease bicycle rentals. Lastly, the data shows that 81% of users are registered users, and as mentioned previously, these users likely rent bicycles during commuting hours. Therefore, PhillyCycle should focus their promotion efforts at satisfying current registered users and retaining more registered users, specifically business professionals.

Introduction

PhillyCycle is a bicycle sharing company based in Philadelphia, Pennsylvania that has seen tremendous growth since starting operations in 2010. The following report analyzes PhillyCycle's customer data from the past two years and draws important conclusions to aid them in future operation expansion and promotion efforts.

Our team of analysts will first examine differences between the two user types, casual and registered users. Next, we will look further into many variables affecting rental numbers and address their statistical significance. Lastly, we will provide suggestions for PhillyCycle to improve operations and expand to new locations in the future with support from trends found in our analysis.

Analysis
Bike Rental Patterns

Summary Statistics of Casual and Registered Users

|	Casual Users	Registered Users
Median	16	115
Maximum	347	876
Interquartile Range	45	184

For my summary statistics, I chose to include median rather than average as a measure of central tendency because the median is almost unaffected by outliers. The median tells us that the middle data point for the number of casual rentals in an hour is 16, while the middle data point for the number of registered rentals in an hour is 115. The maximum values show that the maximum number of registered rentals in an hour is much higher than the maximum number of casual rentals in an hour. The interquartile range (IQR) measures the spread among the middle 50% of the data for each user type. This is useful for PhillyCycle to understand a typical user in each category. Registered users have a higher IQR of 184 compared to an IQR of 45 for casual users. This tells us that registered users have more variation in rentals per hour than casual users, whose rentals per hour are more concentrated around the median. It should be noted that the maximum values and IQR, unlike the median, are not sensitive to outliers.
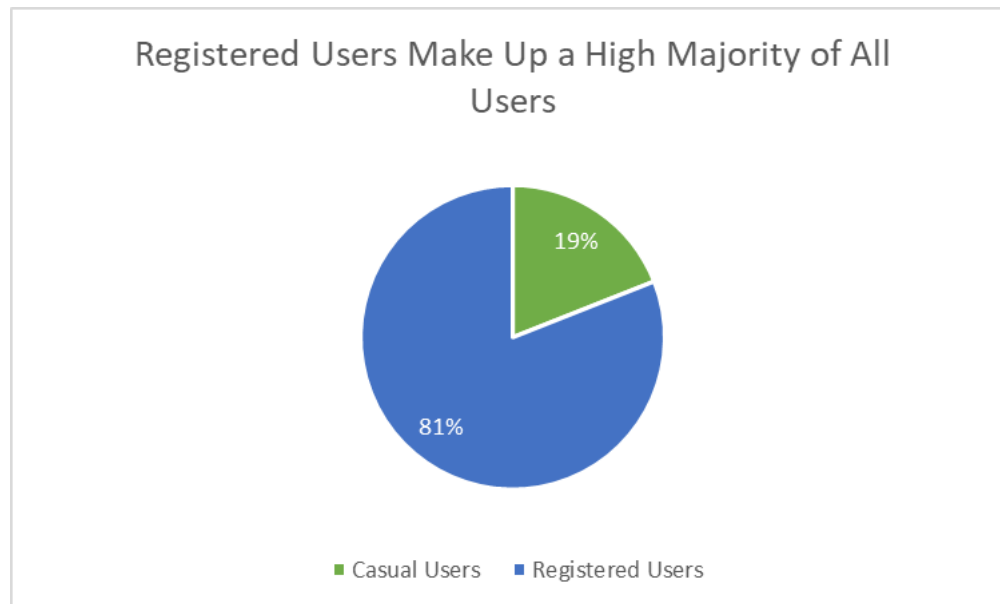

As displayed in the chart, far more PhillyCycle rentals come from registered users (81%) than casual users (19%).

Average of All Hourly Rentals is Highest in Summer
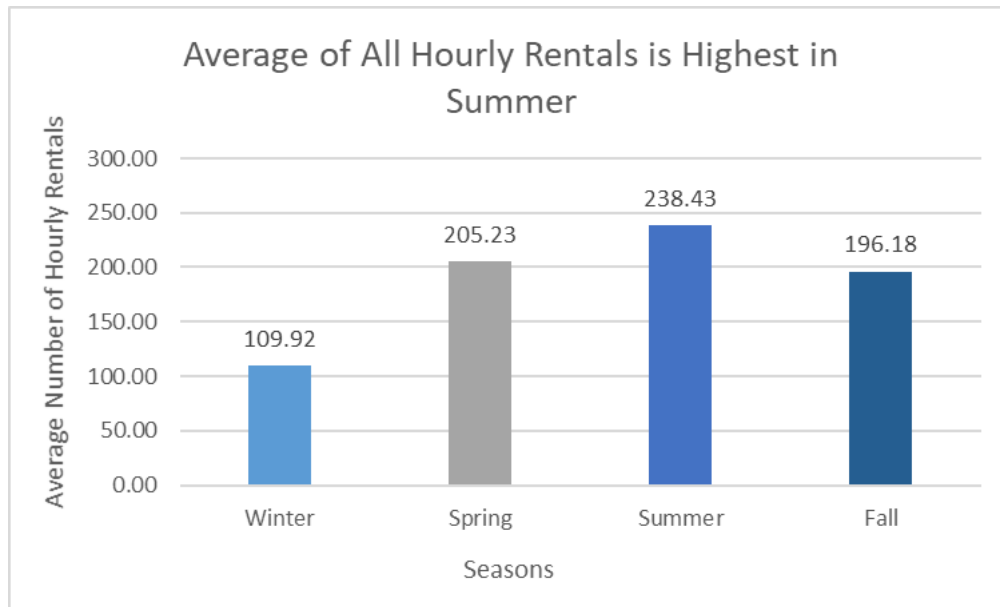
As shown in the column chart, the highest averages for hourly rentals are in the warmer months of Spring and Summer, with Fall and Winter trailing closely behind. The average number of hourly rentals in the winter is less than half of the average number of hourly rentals in the summer.

2012 Has Higher Number of Users Across All Months
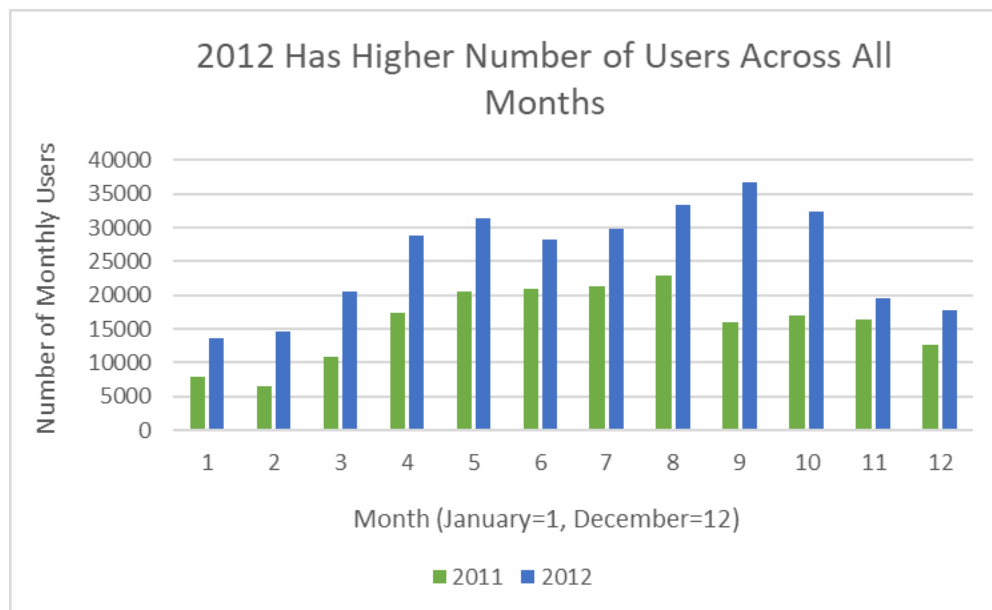
The years 2011 and 2012 show very similar demand patterns. Overall, the year 2012 shows higher numbers of users for each month. This is likely because more people learned about PhillyCycle the following year and therefore demand increased. In 2012, the peak number of monthly rentals occurred in September, skewing the 2012 curve to the right. However, in 2011, the peak number of rentals occurred in August.

Weekend Rental Trends Differ By User Type
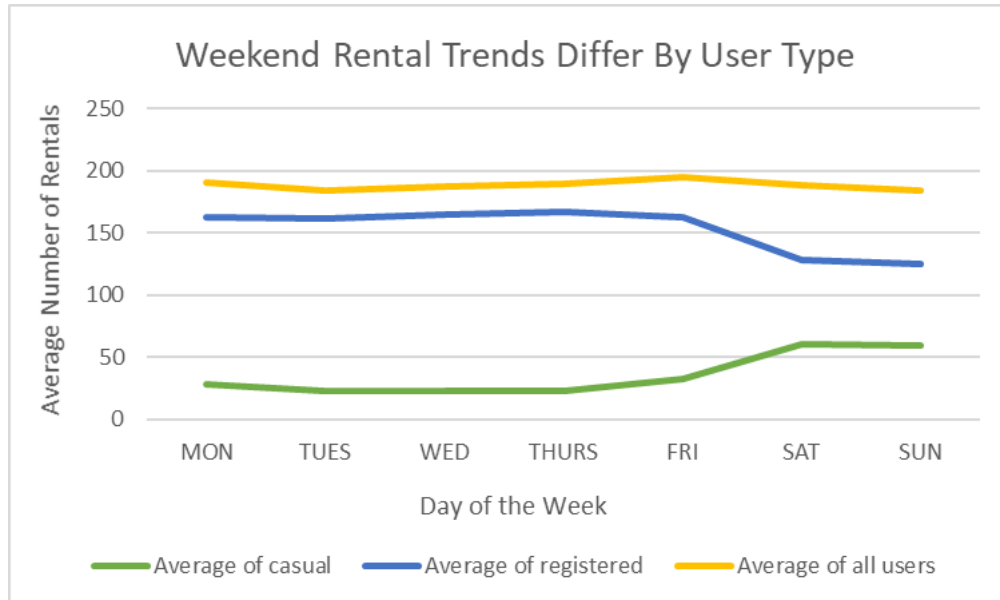
The average number of registered rentals decline during weekend days, while the average number of casual users increases. For all days of the week, the average number of registered rentals are higher than the average number of casual rentals. However, the difference between the two decreases over the weekend day. The number of all users remains relatively consistent across all days of the week, peaking on Friday.


Registered Users Utilize PhillyCycle to Commute

Weekend Trends Remain Consistent Among Both User Types
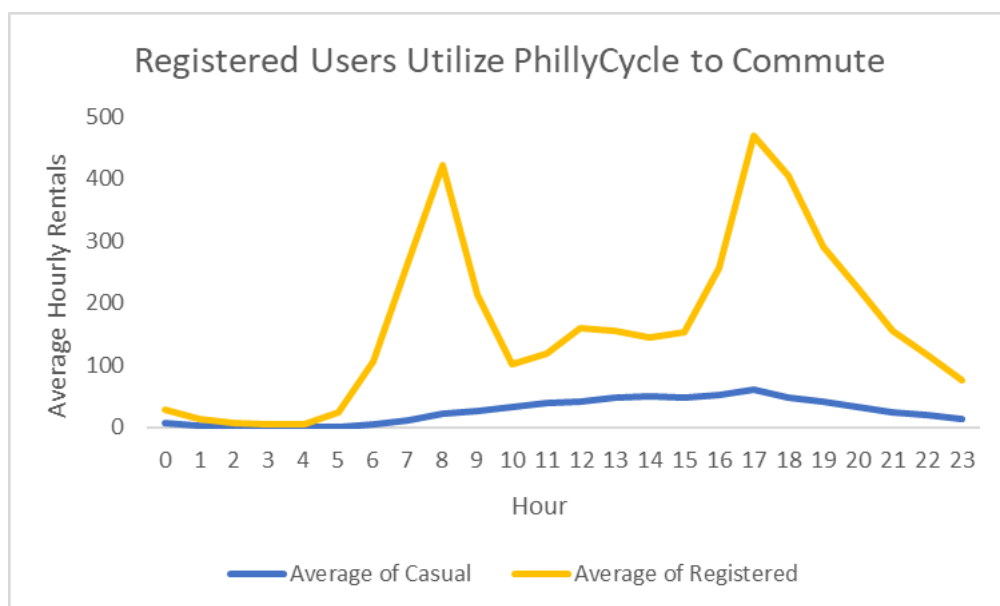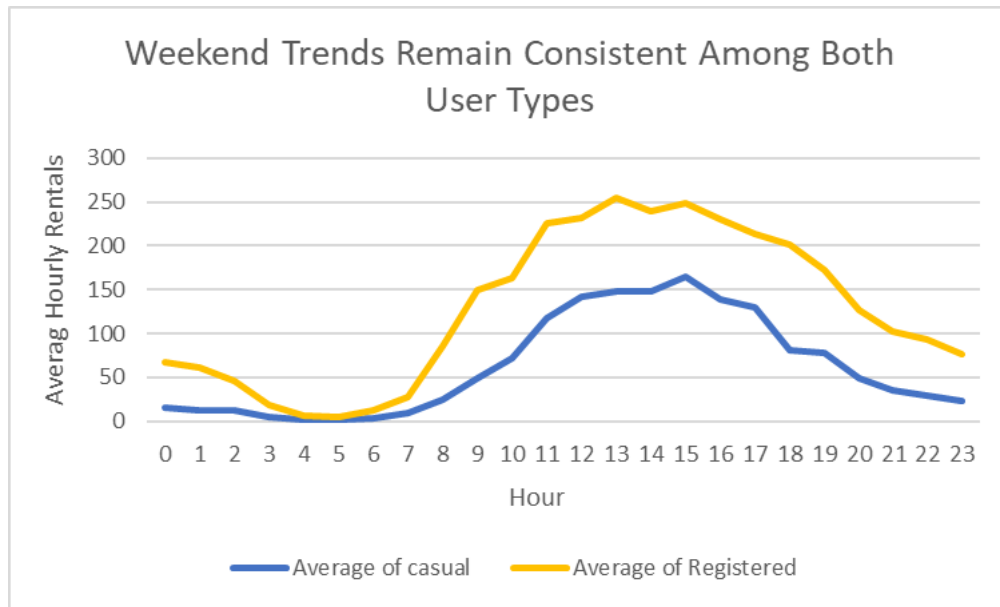
Whereas average hourly casual rentals on weekdays remain consistently under 100 rentals across all hours if the day, weekday average hourly registered rentals have prominent peaks with above 400 rentals around hour 8:00am and 5:00pm. This is likely due to registered uses using PhillyCycle to commute to and from work.
Weekend rentals have similar hourly patterns among registered and casual rentals. However, at all hours of the day registered users have higher averages. Registered rental averages on weekends near registered rental averages around 4-5am.

Majority Number of Hourly Rentals Among Casual Users Are Less Than 50
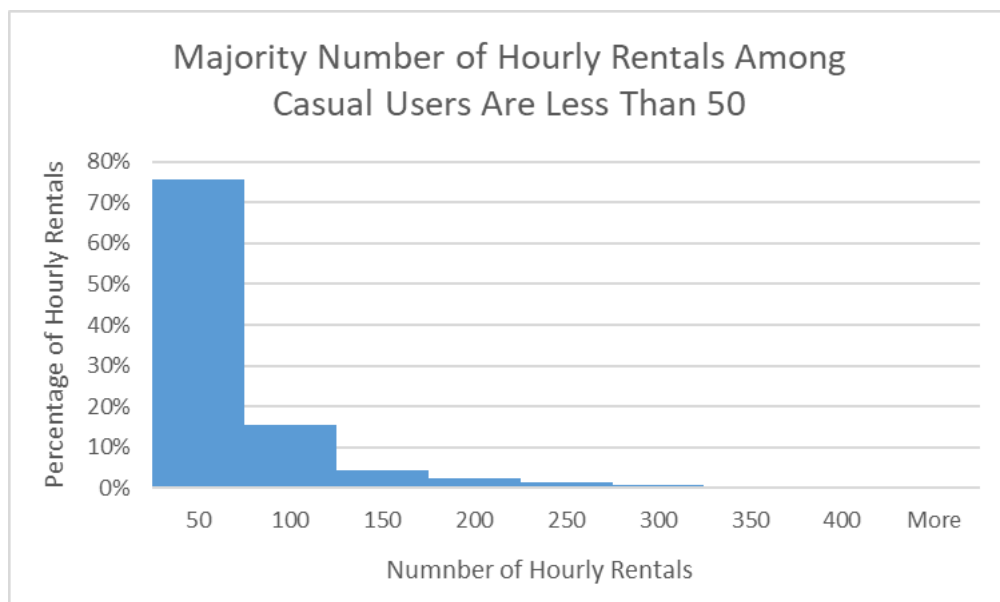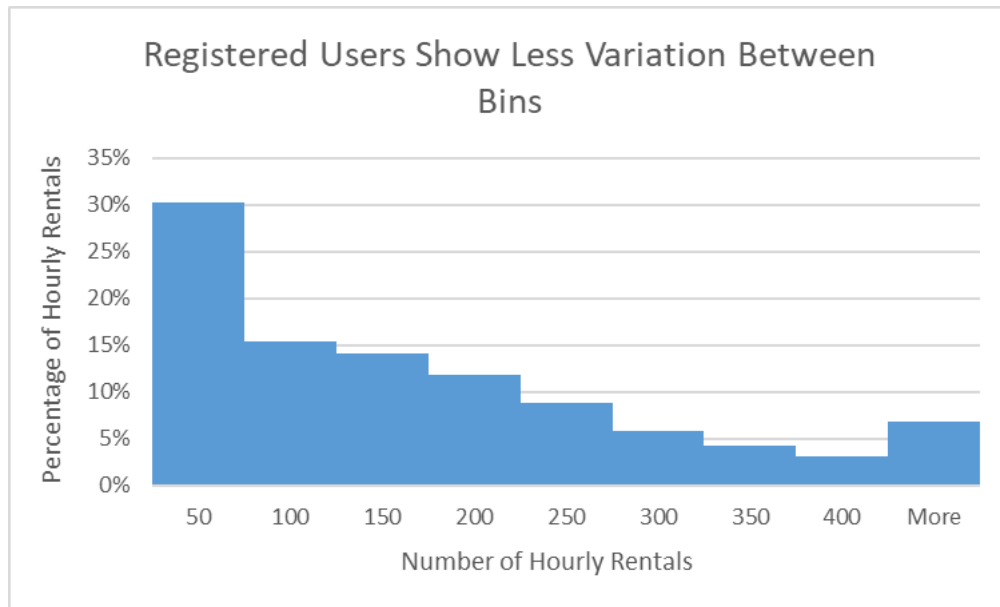
The distributions of frequencies between casual and registered users are significantly different. For casual users, almost 80% of hourly rentals are under 50 bicycles, whereas only about 30% of registered rentals are under 50 bicycles. Overall, registered hourly rentals are split up with much less variation between bins.
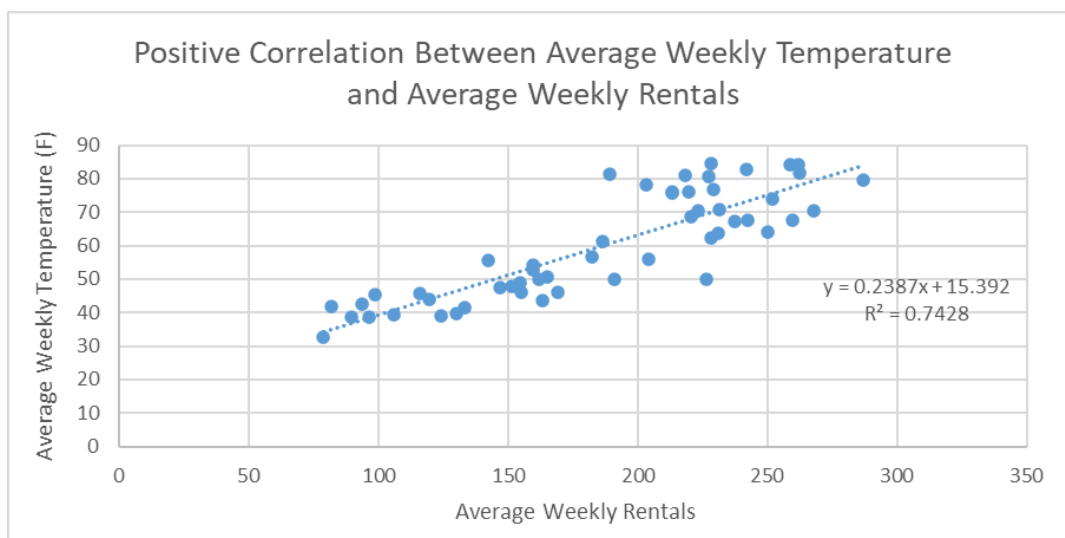
The R-squared value is .7428, which gives an R value of .8619. This value is greater than .7, which means that there is a strong, positive correlation between average weekly temperature and average weekly number of rentals. The equation tells us that a one degree increase in temperature leads to a .2387 increase in average weekly rentals, beginning with 15.392 users.

When examining the difference in weekday and weekend use for all types of users via hypothesis testing, I failed to reject the null hypothesis for all users. I rejected the null hypothesis for casual and registered users. This means there was no significant relationship for all users, but there was a significant relationship for casual and registered users.

Regression Analysis

The following regression analysis was conducted to see how the variation of variables including temperature, windspeed, humidity, mist, precipitation, season, year, and whether it was a weekday or weekend affect the variation in PhillyCycle rentals.

The regression equation is:
Number of rentals = 39.17 + 4.41*Temperature + .75*Windspeed – 2.77*Humidity – .07 * Weekend + 3.03*Mist – 12.97*Precipitation + 11.50*Spring – 16.66*Summer + 56.46*Fall + 71.63*Year2012

Regression Statistics	
Multiple R	0.58
R Square	0.33
Adjusted R Square	0.33
Standard Error	146.45
Observations	2643.00

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	39.17	18.92	2.07	0.04	2.06	76.27
Temp (F)	4.41	0.27	16.51	0.00	3.88	4.93
windspeed	0.75	0.38	1.98	0.05	0.01	1.48
humidity	-2.77	0.18	-15.50	0.00	-3.12	-2.42
Weekend	-0.07	6.30	-0.01	0.99	-12.42	12.27
Mist	3.03	7.00	0.43	0.67	-10.70	16.76
Precipitation	-12.97	11.76	-1.10	0.27	-36.03	10.09
Spring	11.50	10.05	1.14	0.25	-8.21	31.21
Summer	-16.66	12.95	-1.29	0.20	-42.06	8.73
Fall	56.46	9.01	6.27	0.00	38.79	74.13
Year 2012	71.63	5.77	12.42	0.00	60.32	82.94

The R-square value is 0.33, which means 33% of the variation in bike rentals can be attributed to the changes in the variables provided. Temperature, humidity, Fall, and year 2012 all have p-values of 0.00, meaning they are all statistically significant predictors of bicycle rentals at the 1% level because 0.00 < 0.01. Additionally, windspeed has a p-value of .05 which means it is a statistically significant predictor of variation at the 10% level because .05 < .1. All else held constant, for every 1 degree increase in temperature, there is also an increase of approximately 4.41 bicycle rentals. In addition, for every 1 unit increase in windspeed, there is also an increase of .75 rentals. Conversely, for every 1 unit increase in humidity, there is also a decrease of

about 2.77 bicycle rentals. When going from Winter to Fall, there is an increase of roughly 56.46 rentals. The coefficient for summer is negative which could give the impression that there are less rentals in the summer than winter. However, there are actually more expected bicycle rentals in the summer when including the temperature variable in the model. When all else is held constant, the temperature in the summer increases the expected number of rentals more than the summer coefficient decreases the projected number of rentals. Lastly, when transitioning from 2011 to 2012, there is an increase of 71.63 bicycle rentals. Interpretations of mist, precipitation, Summer, Spring, and weekend are not applicable because they are not statistically significant in our model.

Conclusion

The data provided gives insights on many current trends in Philadelphia that will provide PhillyCycle with guidance on how to expand their company in the future. The CEO of PhillyCycle has expressed interest in expanding operation in Philadelphia to better meet demand. After analyzing many variables, current demand in Philadelphia peaks among registered users around 8:00am and 5:00pm, so we assume these customers are utilizing PhillyCycle to commute to and from work. PhillyCycle should implement more bicycles at stations during these time frames to ensure that all customers have access to bicycles when needed. There is a strong correlation between average weekly rentals and average weekly temperature, so in warmer periods PhillyCycle should add additional bicycles to each station to meet this demand. However, humidity is a statistically significant variable shown to negatively impact the number of hourly rentals, so PhillyCycle should closely monitor the forecast of upcoming weeks before issuing more bicycles at each station.

Registered users make up 81% of all PhillyCycle users, and they use the bicycles at much higher rates. Registered users offer PhillyCycle much more consistency than casual users, as they have a membership, so PhillyCycle should capitalize on their success with registered users and focus promotion efforts on this user type. Promotion efforts could include catching the attention of busines professionals who can use PhillyCycle bicycles to commute to and from work. Even further, PhillyCycle can reach environmentally conscious users by emphasizing the positive environmental impacts of commuting via bicycles as opposed to cars or buses. By implementing more stations near business centers, PhillyCycle is sure to see increased profits.

As mentioned previously, there is a strong, positive correlation between average weekly temperature and average weekly rentals. Therefore, when considering expansion to new cities, PhillyCycle should be considering locations with warmer climate and low humidity. Based on the success in a large city like Philadelphia, possibly expansion could include cities such as Las Vegas, Phoenix, Denver, and Salt Lake City.

Appendix

Notes on Data Preparation
Before analyzing the data provided to us by PhillyCycle, we made sure to delete all existing duplicate records. Additionally, we added columns separating data by years, months, and days of the week to investigate rental trends in those areas. We also used dummy variables to gain insights on seasons and weather conditions such as mist and precipitation. Lastly, as PhillyCycle is a company based in the United States where the imperial system of measurements is used, we converted temperature from degrees Celsius to degrees Fahrenheit.
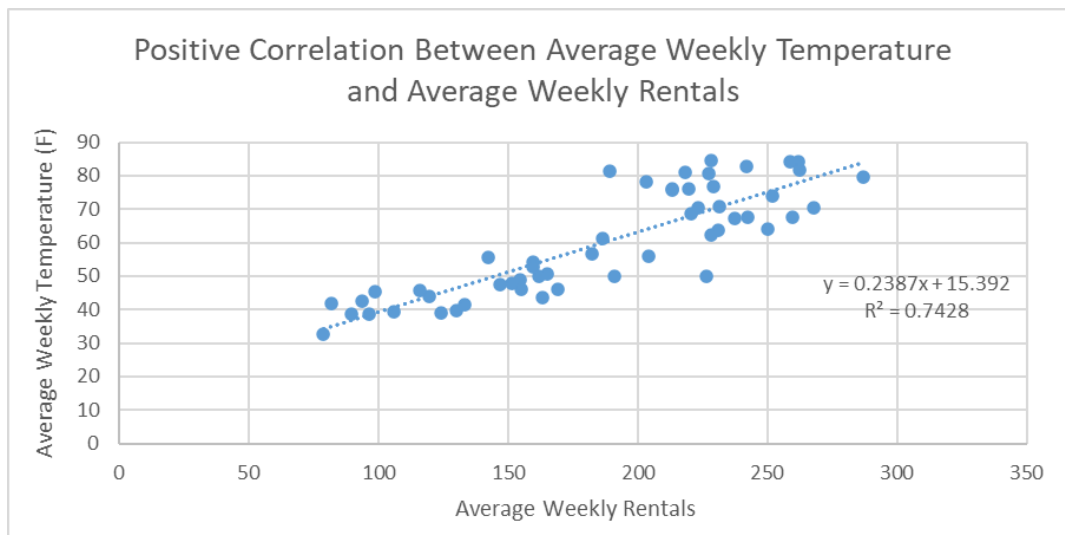
Elevator Charts
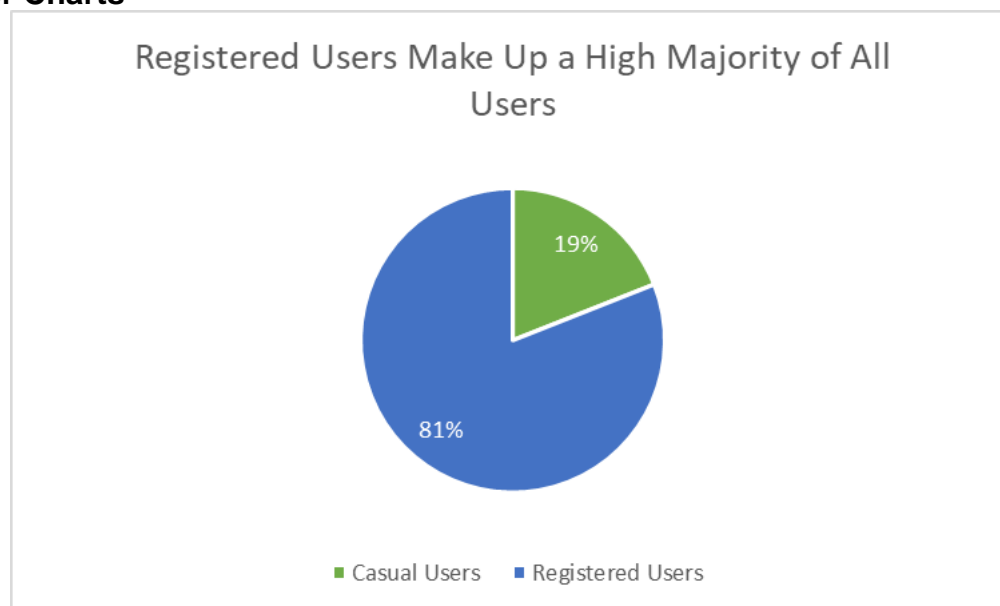
This pie chart displays that 81% of all PhillyCycle users are registered users. When considering future promotion efforts, PhillyCycle should focus efforts towards improving experiences of current registered users and encouraging more people to become registered PhillyCycle users.

Registered Users Utilize PhillyCycle to Commute
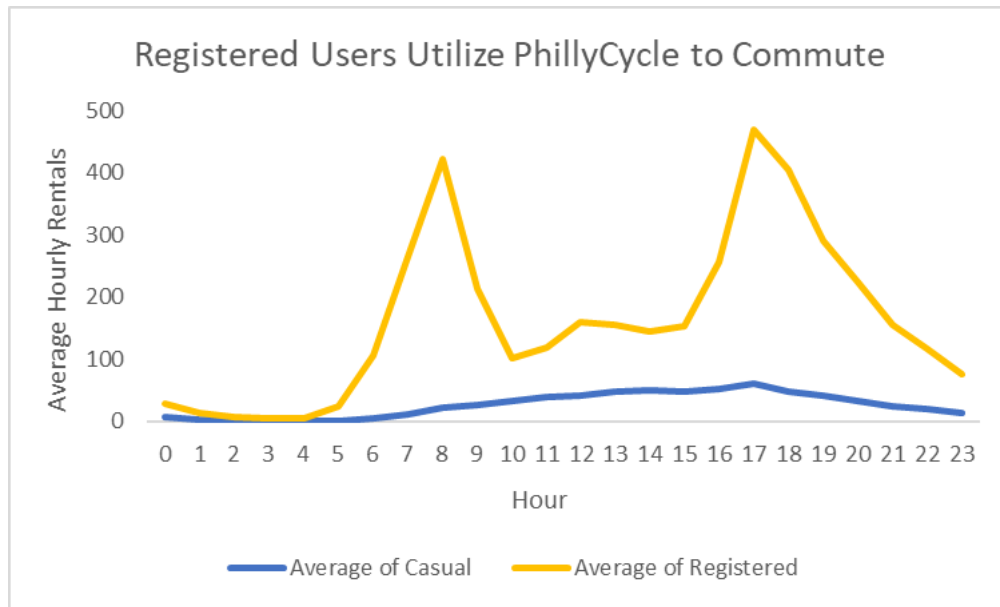
This line chart presents the demand in hourly rentals for both casual and registered user types. It is evident from the graph that demand peaks for registered users during morning and evening commute times. Therefore, PhillyCycle should implement more bikes at stations during these times to meet high demand and ensure all customers have access to bicycles when traveling to and from work. Furthermore, PhillyCycle should also consider catering promotion efforts towards business professionals.

Positive Correlation Between Average Weekly Temperature and Average Weekly Rentals

$y = 0.2387x + 15.392$
$R^2 = 0.7428$

The scatterplot shows a positive correlation between weekly average temperatures and weekly average bicycle rentals. This is important information for PhillyCycle to be cognizant of when monitoring demand and when stocking bicycles at stations in Philadelphia when temperatures increase. Furthermore, this shows that PhillyCycle should consider expanding into cities with warmer average temperatures.