Socio-Economic Impact of Weather Phenomena on NYC Transportation Systems

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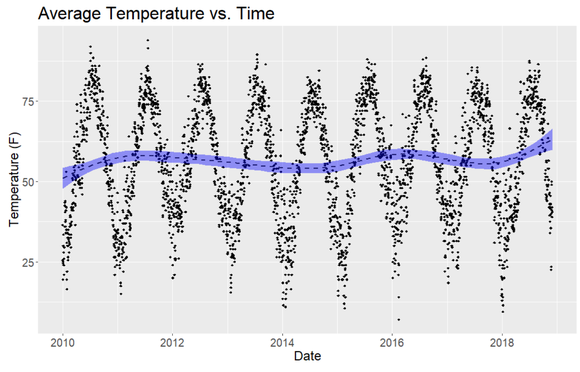
Objectives

- The goal is to determine any correlations between the daily weather and ridership on the subway lines of the Metropolitan Transportation Authority (MTA) and Citi Bike in New York City (NYC).
- The trends will expose any possible impact weather has on these two transportation systems.
- The findings will help the city be better prepared for acute and long-term weather events. The MTA and Citi Bike can use the results to keep and increase their riders.
- The research will be used to make predictions about MTA and Citi Bike ridership in future years as climate change becomes a bigger issue.

Background

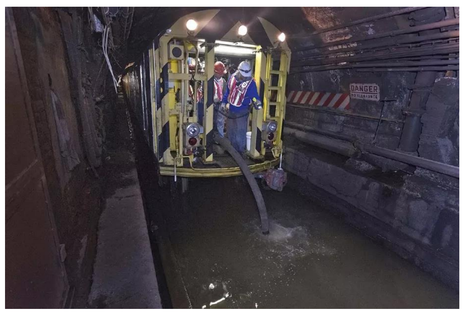
- Climate change affects the use of urban transportation systems, which impacts the local economy.
- During this century, rainfall is expected to increase approximately 10%, and the temperature will increase approximately 10 degrees Fahrenheit in NYC.
- Subway stations often become flooded because their pumps and drainage systems can only manage rainfall at a rate of approximately 1.75 inches per hour. This causes the public to avoid using the MTA.
- In 2012, Hurricane Sandy was extremely destructive; it took the city over $5 billion and several years to repair public transportation.
- On August 8th 2007, three inches of rainfall per hour led to system wide disruptions for MTA subways.
- Citi Bike faces similar issues with ridership during cold months because bikes are taken by the city for maintenance. Hotter months can also present an issue to Citi Bike ridership because cycling can be an intense activity which may lead to heat exhaustion. Most Americans prefer to bike when the temperature is in the sixties.



The average temperature fluctuates seasonally throughout each year. Each year experienced its highest average temperature during the middle of the year, June to August. Lowest average temperatures were recorded in the beginning and end of each year, November to February.

Rationale

- Climate change related shifts in weather patterns can disrupt the economy and infrastructure of the city; thus, it's important to determine how to reduce these disruptions in the future.
- Detrimental effects of climate change on our environment causes safety concerns for the public.
- Studying the potential effects that weather has on transportation systems will help improve the quality of life in New York City.



Metropolitan Transportation Authority / Patrick Cashin, 2012.

WNYC / Kate Hinds, 2014.

Methodology

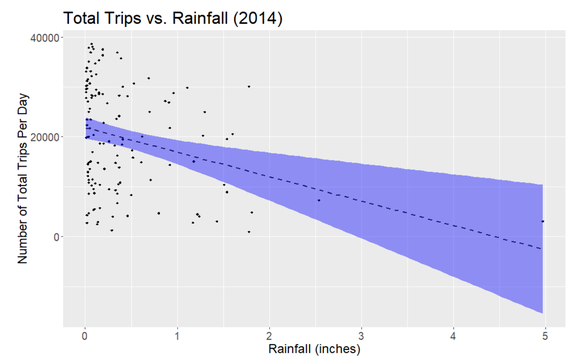
Raw Data → Python → R Studio

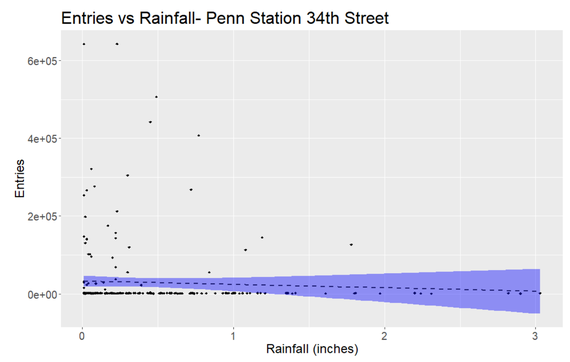
Data was collected from the MTA, Citi Bike, and the National Climatic Data Center of the National Oceanic and Atmospheric Administration (NOAA NCDC). MTA and Citi Bike data was merged with weather data from NOAA NCDC.

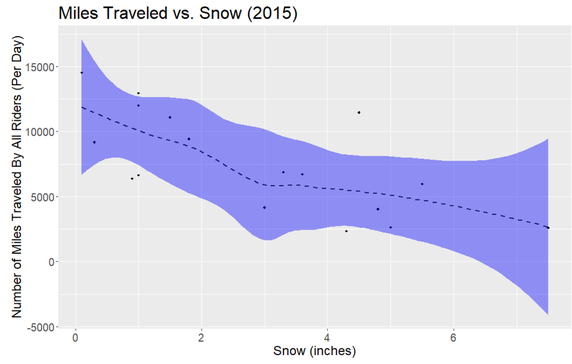
Python libraries Pandas and Numpy were used to clean and process the data into a useable format. Data had to be aggregated, or calculated, into daily timesteps and outliers had to be trimmed out.

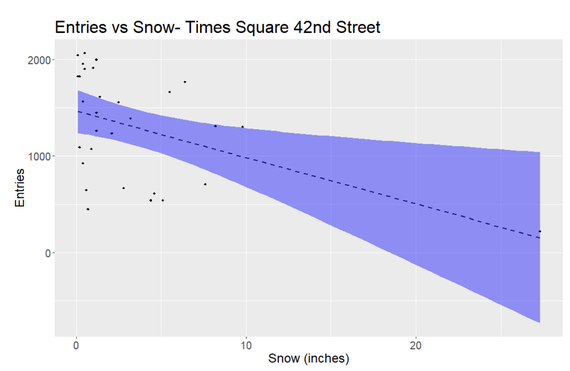
Scatter plots were created using RStudio to determine anomalies and trends. Smoothing curves were added to determine critical trends despite outliers.

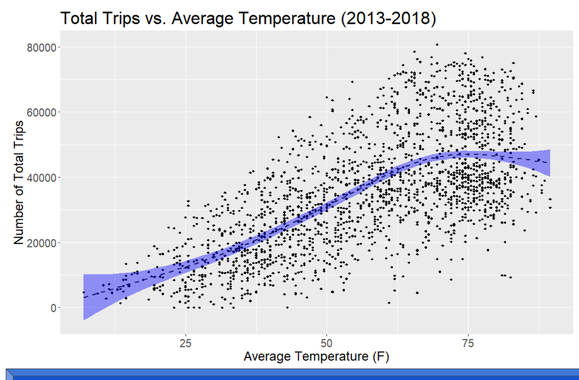
Results

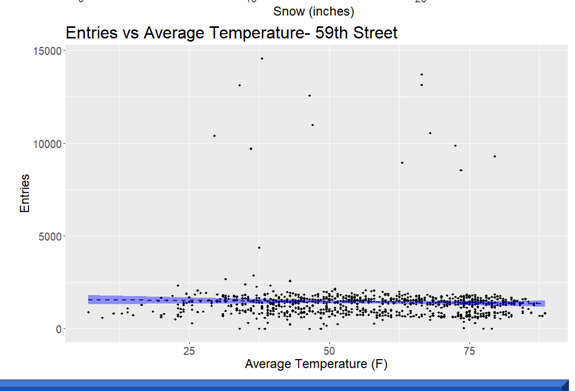












Discussion

- Citi Bike riders traveled a greater number of total trips as the average temperature rose. The rate at which the number of total trips increased differed. In the winter, ridership increased slowly as the average temperature increased since it was still cold. Once the average temperature reached about 75 degrees Fahrenheit, ridership began to decline due to health risks associated with extreme heat.
- Citi Bike ridership continually decreases during rainfall and snowfall, which will persist since climate change causes precipitation to increase. Citi Bike needs to accommodate riders against heavy precipitation to sustain their business.
- Less people used the subway as snowfall and rainfall increased. A decline in ridership on days that experienced snowfall may have been caused by low temperatures and not the snowfall itself. Reduced ridership during both weather conditions would predominantly consist of people traveling for leisure activities.
- MTA ridership observed against average temperature led to different results. Ridership increased up until the temperature hit about 25 degrees Fahrenheit because people avoid using the subway when the temperature is extremely low. Once the temperature had reached 25 degrees, the rate at which people had used the subway versus average temperature had plateaued until about 75 degrees, which is when ridership began to decrease.

Further Research

- It's important to determine trends and correlations on a more granular time scale, so relationships between individual factors may be determined without making assumptions. A smaller scale will also help to understand the cause of the difference in ridership due to weather rather than simply stating the difference during different weather conditions.
- Analyzing train delays for specific train lines might be able to prove that weak train service leads to a reduction in ridership. Additionally, it will provide insight as to which train lines are more susceptible to the weather phenomenon.
- Organize data regarding the weather in an hourly manner to understand during which time of the day rainfall or snowfall occurred. The data can also reveal changes in temperature over the course of a day. This can be used to determine if the changes in ridership occurred at the same time as a specific weather condition. Conclusions about the correlation between ridership and the weather will be more appropriate.

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