Introduction

Share bicycle for the First and the Last Mile Issue in NYC

Transit Oriented Development (TOD) is a method to constrain low density urbanization and suburbanization by focusing on providing transit service along with high density and mixed-use development to encourage transit ridership (Nasri and Zhang 2014). Tons of researches have been done to improve the ridership of the rapid transit, one big part of them is to enhance the accessibility from TOD catchment areas to the transit nodes by providing share bicycles. China, for instance, had almost 300 bicycle sharing programs and had surpassed Italy and Spain to become the country with the largest number of programs in 2015 (Data Center - Climate, Energy, and Transportation | EPI n.d.). Recently, Bike sharing companies landed on New York City where they are trying to implement the mode they created in China (Danielle Furfaro 2017). This paper takes people’s sentiment, bike lane condition, population density, Citi Bike’s usage rate and accessibility to transit nodes as variables and tries to uncover where is the most suitable areas in NYC to put share bicycles.

Data and Method

Bike Route Density

New York City Open Data regularly publishes the bike lanes’ feature data. Based on the level of traffic stress shown in Urban Bike Way Design Guide and ALTA Planning and Design, bike lanes are divided into 12 categories and appropriate scores are assigned to them.

Elevation

10 meters DEM New York State data is used to measure the slope of NYC. Because NYC is a highly developed built environment, so the elevation factor to impact bicycle riding is pretty weak.

Population Density

Higher score is assigned to areas with high population density in NYC. We find out that places around central park have more higher score areas than other places like Brookline and Queens. Downtown Manhattan, to the south of central park, has relatively lower population density since there is few residential areas there.

People’s Sentiment to Bicycles

People’s attitudes, are calculated based on twitter data. We find out people living in lower Manhattan seem to have the most positive attitude to Bicycles where also has the richest bike lane resources. People also hold positive attitude to cycling in central park, where is also a bicycle friendly area.

Bicycle Usage Rate

The ideal data to analyze the bicycle usage in transit stations will be the ground research and data collected on the streets. However, constrained by conditions and other issues, I chose the Citi Bikes’ data as my research basic data. Considering people’s travel behavior may change when weekends come and the limitation of data processing capability, I chose June 1st 2016 and June 4th 2016’s data to analyze the total usage of bicycles. For the Citi Bike usage rate from low to high, one to nine scores are assigned. In weekdays, high bicycle usage rate areas are shown as points in middle Manhattan, which means people seems prefer short trip during workday. On the other hand, in weekends, the dark blue areas are relatively bigger and gathered in Manhattan, which means people travel farther and active in bigger areas on weekends than weekdays.

Suitability

suitability areas in general are calculated out by combining former layers, which are Fuzzy Members. The figure on the left, illustrates the hottest areas in NYC share bicycles may success. The weights assigned to each variables also shown in the table 2.

The most important variables is considered to be bike lane condition which evaluated as 25 percent importance in suitability analysis. Weeklyday bicycle usage rate represent the ability bicycles can split the whole transportation system and population density can embody the bicycle’s usage potential; so 20 percent of the weights are given to each of them. People’s attitudes and weekend bicycle usage both get 15 percent of the weight, which are key factors for the New York City’s highly developed space, so the slope can be very small, therefore, only 5 percent of the weights goes to the elevation factor. We can see in the figure, the most suitable areas to put share bicycles now are located in the middle Manhattan and lower Manhattan.

Location Analysis

The junctions of the bicycle routes are the naturally candidate places to put the bicycles because they are easy for people to identify and access. After assigning the suitability score to those junctions, we can get the suitability score for each of them. We find out the mean of them is 0.21 and the standard deviation is 0.086. Junctions with the top 5% score are considered to be the most suitable places to put the share bicycles, so the junctions with two standard deviation away from the mean are chosen. 175 points were selected to be the best locations to put share bicycles in NYC to solve the first mile problem. All of them are close to the residential areas and have relatively better riding conditions. Those places are where people have relatively positive attitude to bicycles and bicycles are already popular there. Most of those junctions are located in the lower Manhattan and middle Manhattan. Others are aggregated in Roosevelt Island.

Results

175 junctions are selected to be the share bike parking points. In terms of the last mile issue, share bicycles can be fully used if we can locate them at the subway stations. People can travel from the stations to the junctions to park their bicycles and walk to their homes. By using OD Cost Matrix based on distance from stations to the junctions, 84 transit stations are located. They are the ones located within one mile from those selected junctions and the ones to put share bicycles to solve the last mile issue. What’s more, to find where the places are in NYC not only have the best cycling conditions but also can solve both the last mile and the first mile problems. Two service areas are generated by the center of selected junctions and selected transit stations. The service radius of the junctions is designed to be 0.25 mile, since they are used to attract residents within walkable areas. 1 mile radius service area is used for transit stations. As shown in the figure Best Location to Put Share Bicycles, the three blue lines enclosed an area, Best Cycling Areas, our analysis is used for transit stations. People can go to those share bicycles and travel from the stations to the destination. Most of the green lines are categorized by travel distance. The greener the line is, the easier people can travel from a origin to a destination.

Discussion and Limitations

Based on all the analysis above, we find out the best locations to put the share bicycles and the best places in New York City which can make share bicycles to be fully used to improve the city’s public transportation, but if we take a step farther, we can find more issues show up.

Only Rich People Can Ride a Bike

After assigning the suitability score and house holds’ median income into block groups, we can find the high income and high suitability score block groups are clustered together in middle Manhattan and lower Manhattan. We can find that where poor people lives, are lacking of good cycling environment. Although the Local Moran’s I is pretty low, which is about 0.15, still, it is significant because the P value is very near to 0. On the other hand, this research only considers the usage of bicycles. Residents living in those neighborhoods may originally travel more people in other neighborhoods. So, other travel mode should be measured to see people’s total travel behavior.

Data Limitation

The Elevation data is come from New York State, but a small piece of Manhattan is missing, you will find that you take a close look to my figures. So, the analysis is not complete. Moreover, the variables I choose probably not enough and they may have relationship between each other.