Bike Infrastructure Accessibility and Safety in NYC

Final Report
CUSP: Principle of Urban Informatics
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Introduction

Over the past decade, there has been a steady rise in the number of cyclists in New York City, with each year seeing an additional thousand or so cyclists (NYC DOT, 2022). This trend arose for various reasons, including avoiding train delays and heavy traffic (Hu, 2017), and an increase in efforts to make transportation more sustainable (NYC DOT, 2022). With the recent coronavirus pandemic, many also shifted to cycling to avoid crowded areas, bringing about an even bigger push to switch to cycling (von Oldershausen, 2022). However, with this trend, there are also increasing concerns about cycling accidents, as seen from a large reaction to the 2019 spike in cycling fatalities (NYC DOT, 2022).

Picking up on this, New York City has come up with Green Wave: A Plan for Cycling in New York City (NYC DOT, 2019), a new plan to improve bike-friendly infrastructure to improve the safety of cyclists around the city. These infrastructure plans mainly focus on expanding the current protected bicycle lane network, with other measures such as creating more bike share stations.

However, we believe that infrastructure is typically not evenly distributed across the different boroughs within the city. Such uneven access to bike-friendly infrastructure can lead to negative implications in communities and neighborhoods, with a major one being the safety of cyclists. Hence, this project is interested in exploring the distribution of bike-friendly infrastructure in New York, as well as any relationship with the distribution of bike accidents.

Background Information

Bike Infrastructure in NYC

In NYC, there are four different types of bicycle lanes: Protected Bicycle Lane with Access Point, Conventional Bicycle Lane, Shared Lane, and Signed Routes (NYC DOT, 2022). These routes are spread across all five boroughs, and each year, the city embarks on new projects to expand cycling networks. According to the Department of Transportation, from 2014 to 2019, on-street bike networks have increased by more than 330 miles (NYC DOT, 2019). In 2019, a bill was passed by the NYC Council that required the Department of Transportation to create a masterplan that will include the building of an additional 250 miles of bike lanes by 2026 (NYC Council, 2019). However, in John G. Stehlin's book called Cyclescapes of the Unequal City: Bicycle Infrastructure and Uneven Development (2019), it is argued that bike lanes are often only installed in areas where the wealthy are, and hence the cycling lanes could possibly be heavily linked to gentrification and unequal development.

Income distribution

In NYC, income is distributed quite unevenly across and within the five boroughs. Table 1 shows the median income per borough in 2019 and Figure 1 shows a map of the median household incomes per census block.

Table 1: 2019 Median household income by borough[1]

Borough	Median Household Income
Bronx	$41, 432
Brooklyn	$66, 937
Manhattan	$93, 651
Staten Island	$89, 821
Queens	$73, 696

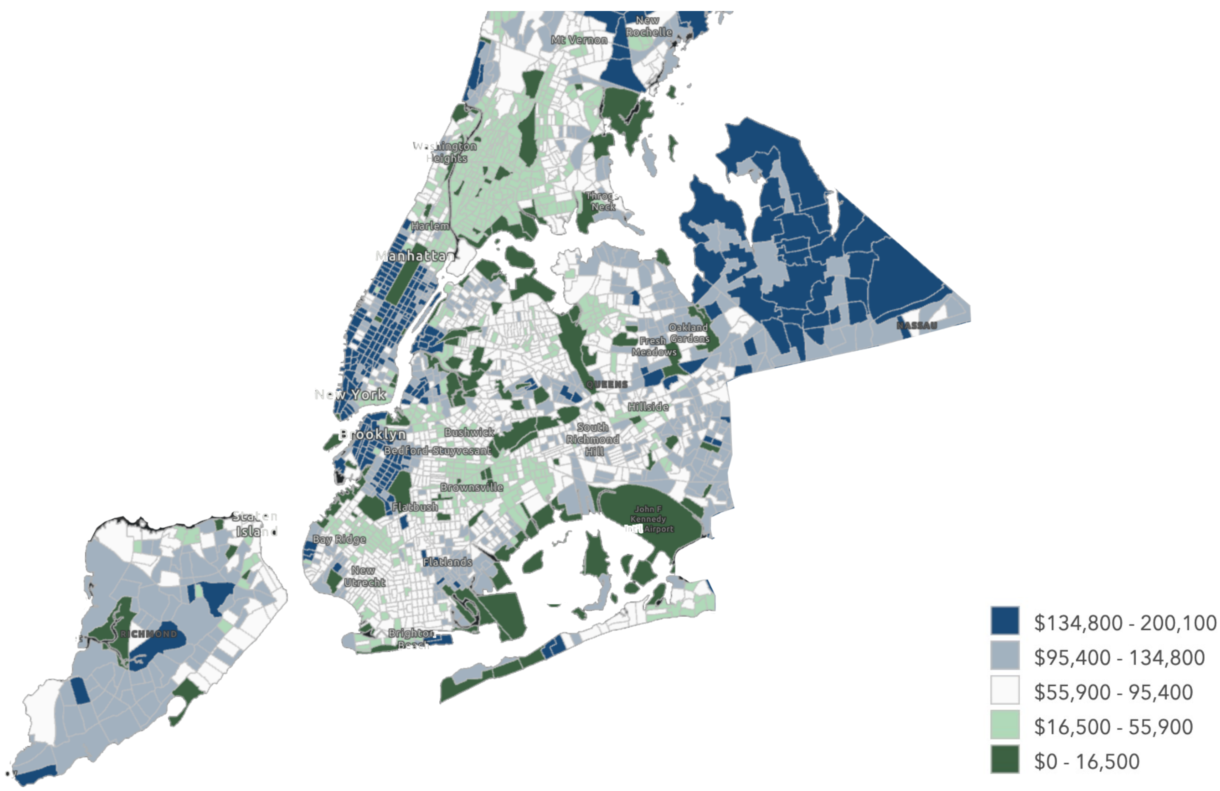


Figure 1: Snapshot of Median Household Income in NYC by Census Blocks, with American Community Survey (ACS) 2017-2021 5-year estimates data (Carroll, 2022)

[1] https://data.cccnewyork.org/data/table/66/median-incomes#66/107/62/a/a

Accident Reports and Stats

From research done by the NYC DOT, statistics seem to imply a reduction in the number of severe accidents as bike-friendly infrastructure increases. Figure 1 illustrates the number of people killed or severely injured (KSI), and the KSI per 10 million cycling trips. There is a clear downward trend for the KSI per 10 million cycling trips. However, these statistics are only available for the whole NYC, and are not broken down by borough. We would like to explore this in greater detail within each borough and down to the zipcode level to explore how this is distributed within communities.

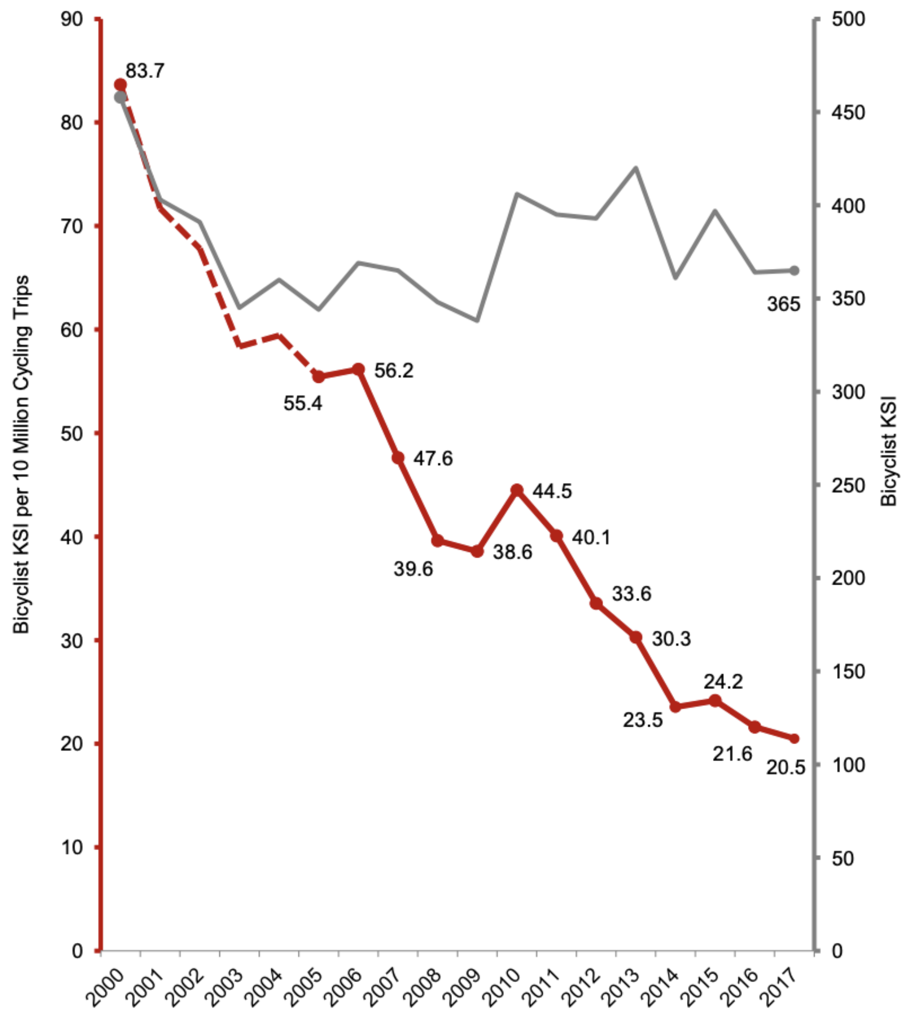


Figure 2: New York City Cycling Risk (DOT, 2022)

Since there seems to be a downward trend and pattern to how bike friendly infrastructure positively impacts the community by reducing accidents, we are interested to see how this is true across various zip codes and whether such infrastructure is evenly distributed.

Research Questions

From the above background information, we have come up with two research questions.

1. What is the relationship between bike-friendly infrastructure and bike accidents?
2. What is the current accessibility of bike-friendly infrastructure in NYC? How is it distributed among different communities?

Data Sources

1. *New York City Bike Routes*
2. *NYC Open Data*
3. *Citi Bike Data*
4. *Citi Bike System Data*

The dataset contains citibike data and the locations of bike lanes and routes for the five boroughs of New York City provided by the Department of Transportation (DOT). We use this dataset to understand the infrastructure for biking in every Zip Code in the city.

5. *Motor Vehicle Collisions - Crashes*

Each row in this dataset represents a crash event in New York City. We see the vehicle types involved in a crash, and the number of motorists, pedestrians, and cyclists who were injured and killed in the crash event.

6. *Census Bureau Tables*

The Census Bureau tables have data on the median income in each zip code of New York City. The 2020 ACS 5-Year Estimates for the median household income will be used to assess the economic strength of residents of any zip code.

Methodology

Collecting data from various sources is essential to performing any data analysis. In this case, data was collected from NYC Open Data, US Consensus, and Citibike and was used to answer questions about the relationship between bike-friendly infrastructure and demographic factors and the relationship between bike-friendly infrastructure and accidents.

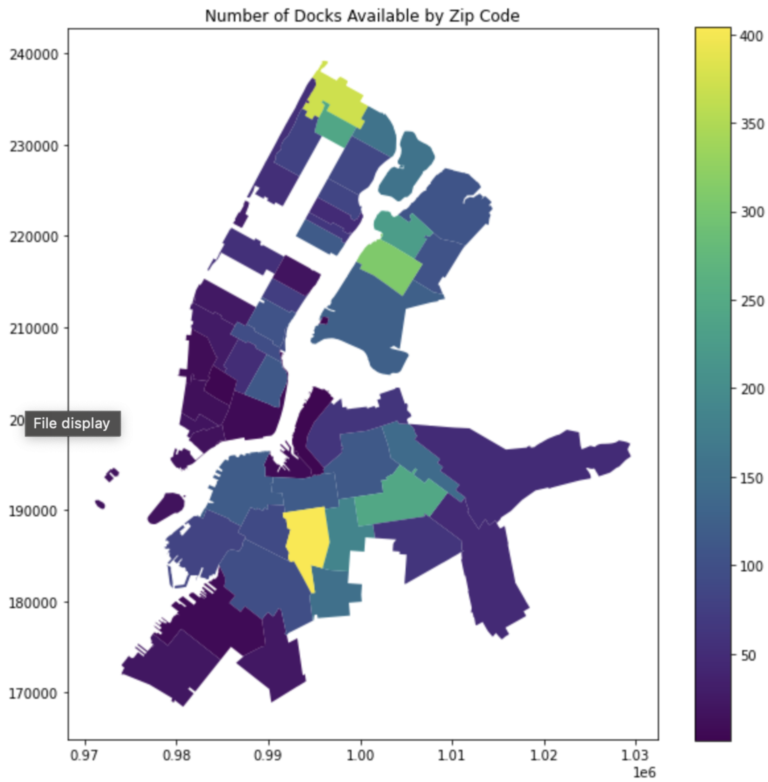


Figure 3: Number of Citibike Docks Available by Zip Code, map generated using data from Citibike, NYC Open Data and US Consensus

Many columns are dropped from the original data sets, including start time, stop time, and trip duration information. Instead, the data focus on latitude and longitude, Station ID, and the number of docks available at each station.

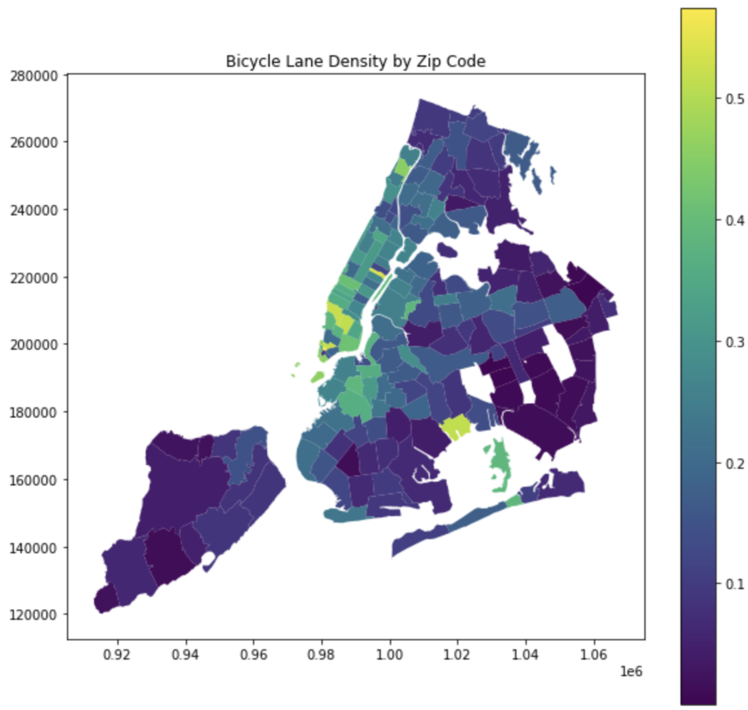


Figure 4: Bicycle Lane Density by Zip Code, map generated using data from Citibike, NYC Open Data and US Consensus

Bike lane density was calculated for each zip code by dividing the length of bike lanes by the total street length, giving a proportion of streets with bike lanes. Once the data had been cleaned and processed, it was merged into a single, unified data set. This allowed for more sophisticated analyses, such as regression, to be performed on the combined data.

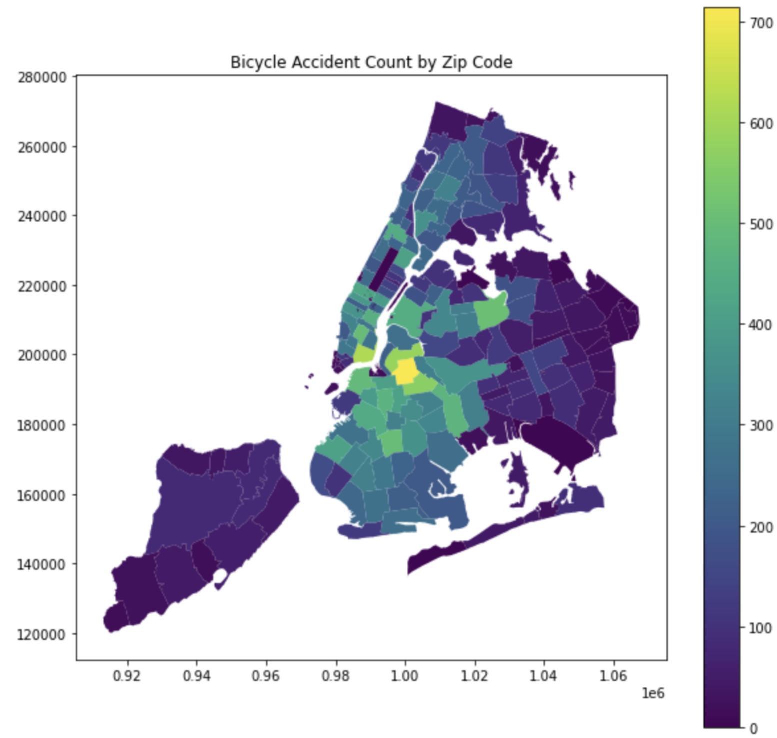


Figure 5: Bicycle Accidents by Zip Code, map generated using data from Citibike, NYC Open Data and US Consensus

Regression analysis was used to answer questions about the relationship between bike-friendly infrastructure and demographic factors and the relationship between bike-friendly infrastructure and accidents.

One of the key relationships we tried to establish by performing a regression analysis between bike-infrastructure and demographic factors. Another regression analysis was done to see if there is a relationship between bike-friendly infrastructure and bicycle accidents.

It is assumed that zip codes with higher levels of bike-friendly infrastructure tend to have lower levels of accidents involving bicycles. Having more bike-friendly infrastructure in an area can help reduce the number of bicycle accidents.Overall, the analysis of data collected from NYC Open Data, US Consensus, and Citibike reveal essential insights about the relationship between bike-friendly infrastructure and demographic factors, as well as the relationship between bike-friendly infrastructure and accidents. By understanding these relationships, policymakers and city planners can make informed decisions about how to improve bike infrastructure in order to promote safety and accessibility for bicyclists.

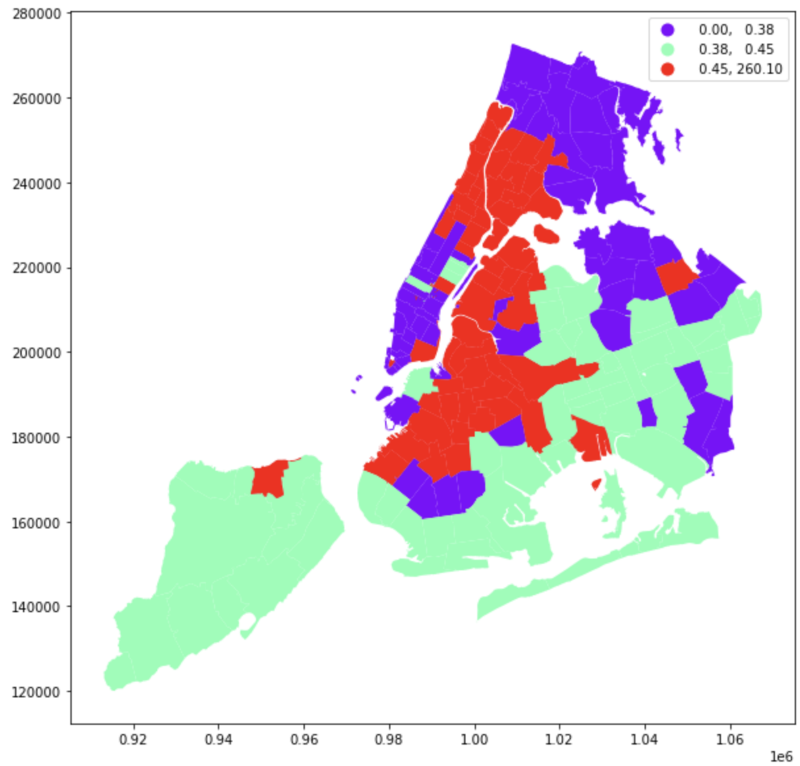


Figure 6: Low, Medium, High Normalized Accident Count with Normalized Citibike Trips

Results

Regression analysis is a statistical method to forecast the relationship between different variables. A regression model has been created in the given scenario to forecast the relationship between bike lane density, population density, white population percentage, and mean income. The model was created using polynomial and log transformations, allowing for a more accurate data analysis.

The first regression analysis shows that there is a linear relationship between bike lane density and mean income. It means that as the population's mean income increases, bike lanes' density increases. It could be because individuals with higher incomes are more likely to use bike lanes for transportation, leading to a higher demand for bike infrastructure.
Additionally, the analysis showed that bike infrastructure has a quadratic relationship with population density. This means that as the population density increases, the bike infrastructure also increases, but at a diminishing rate. This could be because in areas with higher population densities, there is a greater need for efficient and sustainable transportation options, such as bike lanes.

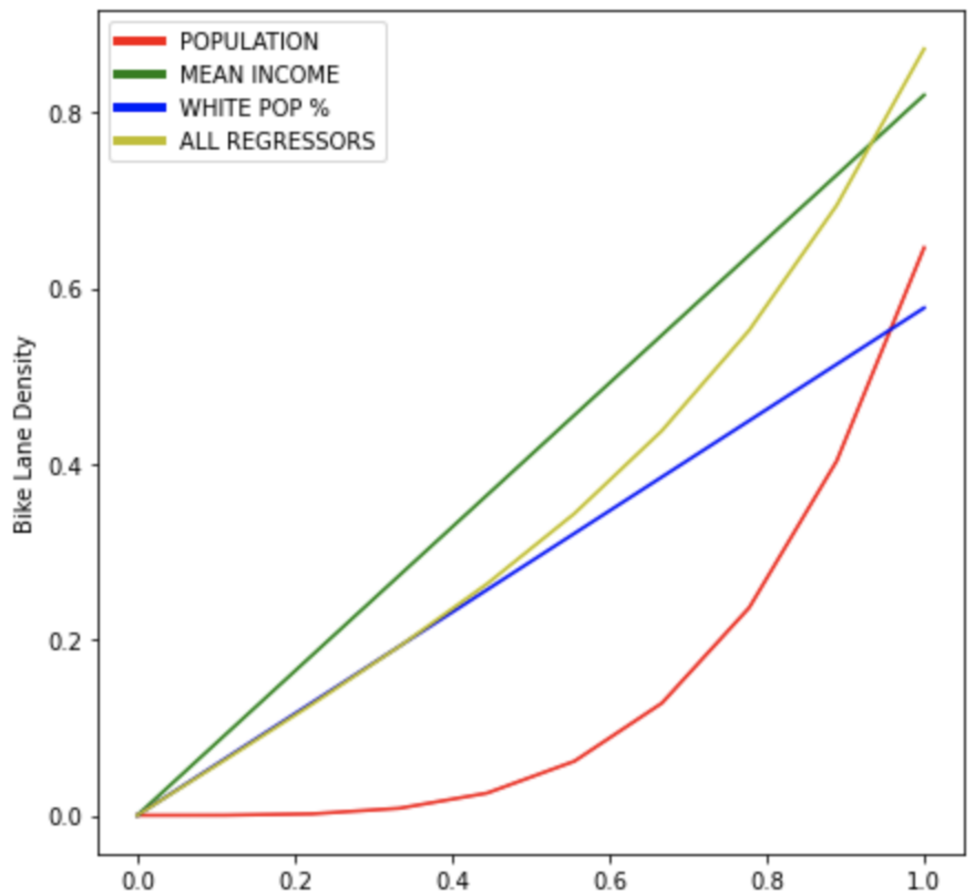


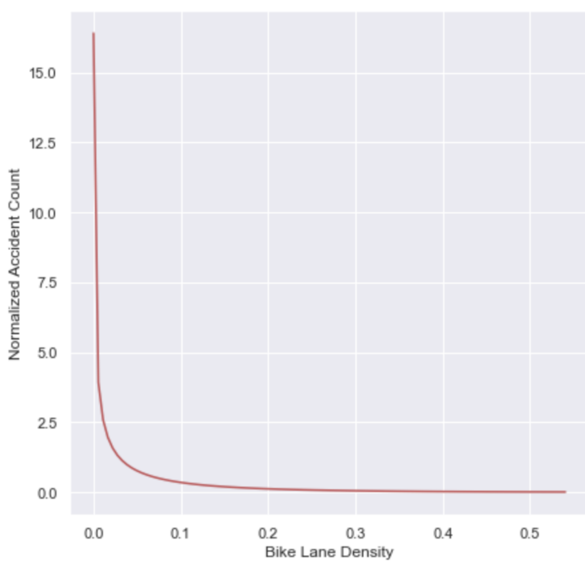
Figure 7: Regression of Population Density, Mean Income and Percentage White Population against Bike Lane Density

The results also showed a linear relationship between the white population percentage and bike lane density. It could be because white populations are more likely to have the financial resources to support the development and maintenance of bike infrastructure. However, it is critical to note that this relationship does not necessarily imply causation, and further research would be needed to determine the exact reasons for this relationship.

The regression analysis provides valuable insights into the relationship between bike lane density, population density, white population percentage, and mean income. The results suggest that for a higher density of bike infrastructure, there needs to be a combination of high income, high population density, and a high percentage of the white population. While these findings can inform policy decisions and planning, it is essential to consider other factors that may also impact the demand for bike infrastructures, such as the availability of alternative transportation options and the overall level of support for cycling in the community.

The results of the second regression analysis showed that there is a negative log relationship between bike lane density and bike-related accidents. It means that as the density of bike lanes increases, the number of bike-related accidents decreases. It could be because more bike lanes provide safer routes for cyclists, reducing the likelihood of accidents.

The analysis also showed a critical density of bike lanes, after which the decrease in bike-related accidents became steeper. There is a point at which the addition of more bike lanes has a significant impact on reducing accidents. Determining this critical density of bike lanes could be helpful in planning and policy decisions, as it can help to identify the optimal level of investment in bike infrastructure.



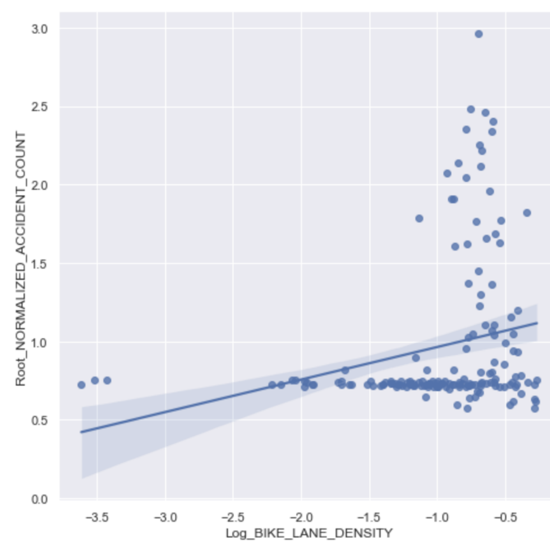


Figure 8a: Normalized Accident Count vs Bike Lane Density
Figure 8b: Log of Normalized Accident Count and Log of Bike Lane Density

However, the density of bike lanes does not solely determine bike accidents. Other factors, such as the bike lanes' quality and the bike traffic level, can also impact the number of accidents. For example, poorly maintained bike lanes or high levels of bike traffic may increase the likelihood of accidents, even in areas with a high density of bike lanes. Therefore, it is crucial to consider these factors in addition to bike lane density when planning and to implement bike infrastructure.

Conclusion

We conclude that it is highly likely that there is a strong link between having more bike infrastructure and a decreased risk in bike accidents. Hence the expansion of the bike network by the Department of Transport is one development which our evidence supports. However, it does also seem that there is also correlation with lower bike infrastructure and lower income levels, and white population percentage. This shows that there might be a relationship there, and some injustice in accessibility of bike infrastructure, leading to discrimination to some members of the community. This may have negative impacts on these communities of lower income levels and minority racial groups. This point is one that we feel would require more in depth research as there are social implications to having an imbalance of bike lane implementations.

One possible extension to this project would be to go deeper into how bike infrastructure might be linked to gentrification, as Stehlin (2019) suggests. Most bike infrastructure results today are based on existing frameworks, which are mainly located in relatively wealthier areas. Hence many underlying assumptions are made in understanding the benefits and patterns of such results. In lieu of this, there have been studies that show how communities are differentially affected by bike infrastructure. One of these studies, by Lusk et al. (2017), showed evidence of this in Roxbury Massachusetts. Another study by the Collaborative Sciences Center for Road Safety headed by Florida Atlantic University (Dumbaugh et al, 2020) also goes into a detailed study on how the built environment differentially affects the crash risk in communities of various income groups.

Another possible extension is to see how bike infrastructure affects attitudes people in each community have about biking. Since there is a push for greener and more sustainable transport such as cycling, we should investigate how infrastructure could encourage such shifts in behavior. This research would require the collection of much qualitative data.

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Appendix

Team Members and Roles

Project Topic Synthesis: All

Research Plan
Background Research: Natalie Quah, Yu Ze Toh
Methodology: Punit Vats Thakur
Data Sources: Ajayrangan Kasturirangan, Akshay Shetty, Sharvari Deshpande

Final Paper
Writing of paper and presentation slides: Natalie Quah, Punit Vats Thakur
Data analysis: Ajayrangan Kasturirangan, Akshay Shetty, Sharvari Deshpande, Yu Ze Toh
Interpretation: All
Presentation: All

Github link

https://github.com/ajay1808/Principles-of-Urban-Informatics-Project