Bike Infrastructure in Copenhagen

An analysis of accessibility and quality of cycling infrastructure in the neighborhoods of the Danish capital.

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Introduction

Biking constitutes an integral aspect of Copenhagen's identity. Throughout the week, cyclists collectively travel a distance of 1.44 million kilometers per day on the city's 385km extensive biking network Copenhagen's bike culture | VisitCopenhagen. Nevertheless, the municipal government is still pushing forward new ideas and projects to further increase the number of journeys done with a bike.

To delve deeper into this phenomenon, we embarked on a journey to map out and analyze the spatial distribution of bike lanes and additional cycling-related facilities within Copenhagen, one of the globe's most bicycle-friendly cities. Our initial exploration provides a snapshot of the variances in both accessibility and quality of the bike infrastructure that exists. Following this, we integrated these spatial differences with socioeconomic data to explore potential correlations and identify what characteristics might influence the quality and availability of biking infrastructure provided. This multifaceted approach aims to shed light on how Copenhagen continues to evolve its bike-friendly landscape, ensuring that cycling remains an accessible and preferred choice for its residents.

Method

The scope of this analysis is confined exclusively to the municipality of Copenhagen. To stay within the scope and capabilities of our course only already existing data has been used. The carried out work followed the available information.

The data used is provided by the municipal authorities and was mostly published in 2018. All the datasets that have been used are listed in the appendix. In accordance to the level of detail provided by the data, our analysis focuses on 67 pre-defined neighborhoods. All the layers were adjusted to fit to this alignement.

Heat Map of Bike Infrastructure

After collecting and sorting out available data, the first step was to carry out an overlay analysis. With the help of the "Multiple Ring Buffer"-Tool different scores were assigned to places around the city depending on the proximity to the respective feature. The four considered aspects (and assigned scores) are:

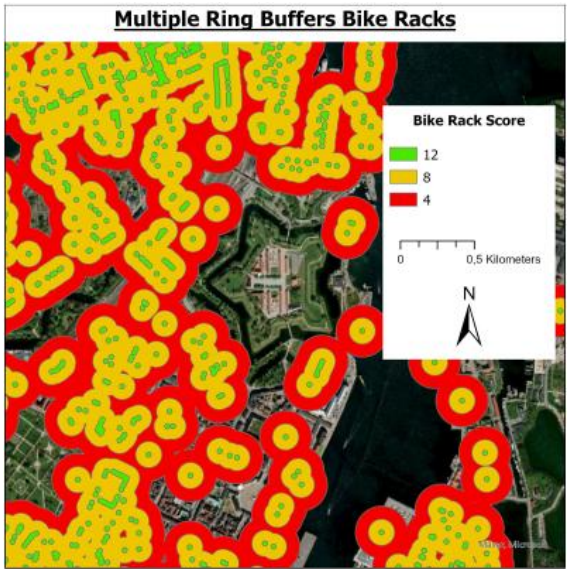

Fig. 1) Example of one of the four considered aspects

- Existing bike lanes (75, 30, 10)
- Bike racks (12, 8, 4)
- Blue corridors at intersections (8, 4, 2)
- Bike ramps (5, 3, 1)

The highest score of all 4 variables together adds up to a 100. All points on the map therefore fall into the range of 0 (no infrastructure) to 100 (excellent infrastructure). These scores are not based on specific investigations, bur rather on our assumption about the relative importance of the features.

Socioeconomic Variation

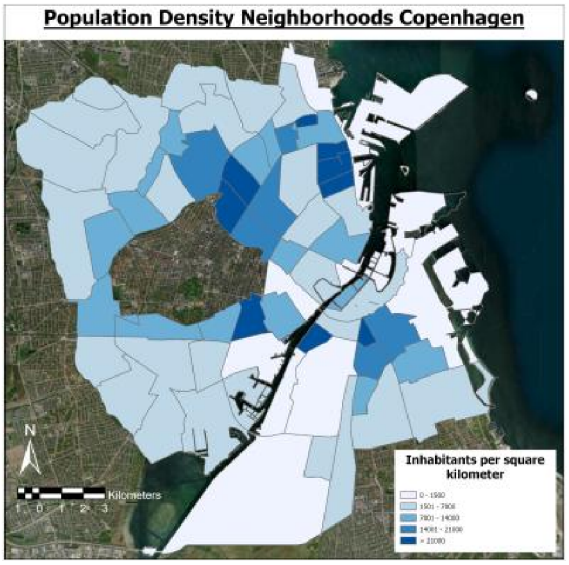

Fig. 2) Example of one of the four considered socioeconomic characteristics

In a second step we tried to link the discovered differences with possible socioeconomic characteristics. To get insight into this correlation we used socioeconomic data collected by the municipality.

After we aggregated the data to the data layer with the neighborhood polygons we looked into the joint distribution between the socioeconomic variables and the average biking score. We looked into:

- Population density
- Share of Danish residents
- Income

This section is not exhausting. There are many more plausible attributes that could potentially explain the observed differences in the accessibility of biking infrastructure.

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Results

Spatial Difference in Bike Infastructure

The used data clearly shows that the provided biking infrastructure is better and also denser around the core of the city. Looking in to the outskirts of the city bike paths are usually further apart and also the availability of bike racks, ramps and blue markings at crossings is lower.

Figure 3) shows a detailed map with all of the over 2000 small polygons representing the calculated biking infrastructure

score. They are the result of the overlay of the four considered features. Explore it yourself in the interactive map...

Fig. 3) Assessment of bike infrastructure quality on a scale from 0-100. Dark blue (0), red (1-20), orange (21-40), yellow (41-60), lime (61-80) and green (81-100).

To get a clearer and easier to interpret picture we then aggregated the smaller polygons into the 67 neighborhoods using the simple weighted average. The result of this is shown in Figure 4). The highest average scores can be found in close proximity to the center. Areas with the best infrastructure are Østerbro, Nørrebro and the area around the central station.

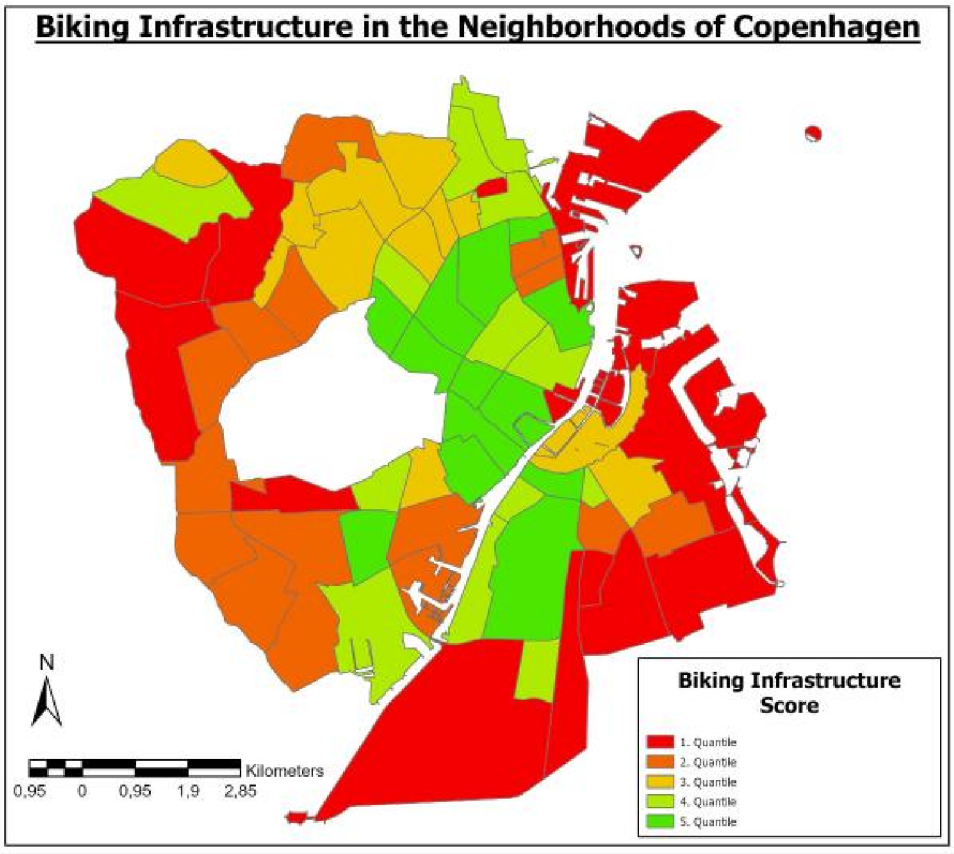

Fig. 4) Average Biking Infrastructure Score in Copenhagen´s neighborhoods. The 67 polygons are separated into five quantiles.

What could be part of the reason for this?

In order to get a better understanding of the spatial differences we compared our quality assessment with available socioeconomic data. More specifically our analysis focused on: population density, share of Danish residents in the neighborhood and percentage of people with a high (middle and low) income. For our analysis we used the statistics tool in ArcGIS Pro to create plots. For a more sophisticated analysis one could for example use multivariate regression tools.

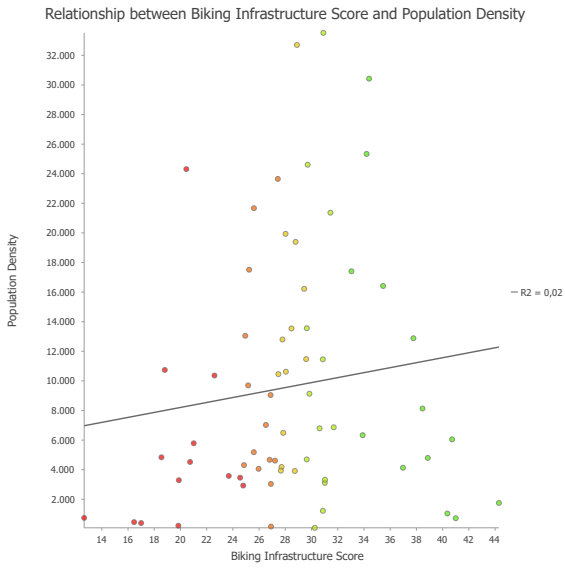

Fig. 5) Correlation between the biking infrastructure score and population density

In Figure 5) the relationship with the population density is portrayed. In neighborhoods with more people per area there

is somewhat a higher cycling score, but the correlation found is only weak. Moreover, the density values varies quite substantial over the different neighborhoods with a minimum of a few hundred people to almost 33'000 people per square kilometer.

Looking at the share of Danish citizens (people that inherited their Danish citizenship by birth) in the neighborhoods gives a more defined correlation. Figure 6) shows a positive trend. However, this might be due to the extraordinary low shares in a handful of neighborhoods.

Fig. 6) Correlation between the biking infrastructure score and share of Danish residents in the area

Before we started our analysis we were pretty sure to find the clearest correlation between the cycling infrastructure and income. As seen in Figure 7) our data, however, does not show any kind of correlation between share of resident with a high income and the biking score. We also looked into low and middle income but there was also no trend visible.

With the used data and the considered socioeconomic variables we were only able to find some weak correlation to the biking infrastructure score. This might be due to many things such as:

- The approach used to assigned the scores to the considered biking attributes
- Omitted variables in our score analysis
- Data quality and accuracy

Many other things of course influence the construction and maintenance of the cycling paths and could be further

investigated in a future analysis.

Note: The color of the points correspond to the distribution of the scores from Figure 4).

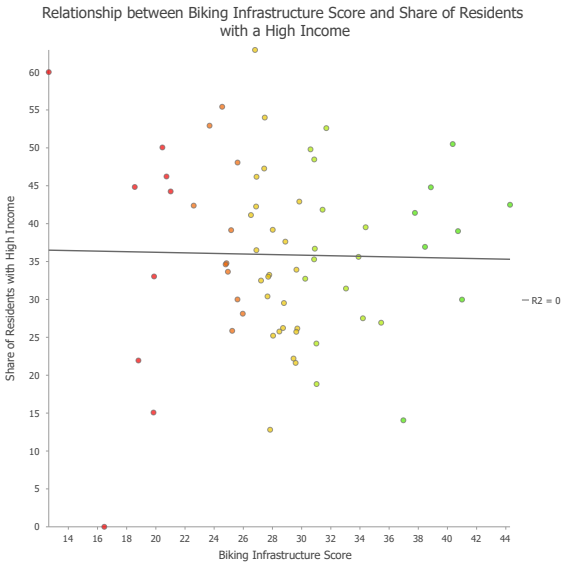

Fig. 7) Correlation between the biking infrastructure score and share of residents with a high income

Conclusion

Cycling offers numerous benefits to human health and serves as a crucial component in steering society towards a more sustainable, low-carbon future. Its potential is particularly significant in urban contexts. Copenhagen has dedicated considerable effort, financial resources, and space to enhance its cycling infrastructure, earning it a reputation as one of the most bicycle-friendly cities worldwide for several years now.

Keeping this in mind none of the made assessment wants to indicate that there is a bad bike infrastructure provided in parts of the city. The analysis has to be seen from a relative point of view: Where is the infrastructure good and where is it even better?

Closer to the center of the city the scores are higher. Many bike lanes coming from the suburbs and meet in a the cities core. Our findings suggest that there are only weak socioeconomic explanations for the differences across

neighborhoods. In out case the clearest explanatory variable being the share of danish people living in the neighborhood.

It would be interesting to refine the made analysis in a future project and try to include more aspects in the overlay analysis (quality of the infrastructure, width of bike lane, number of crossings, etc.) and see how this changes the correlation to other socioeconomic variables (age, children, education, etc.). ArcGIS Pro has a variety of spatial analysis tools that could help to investigate this relationship (network analyst, different types of regression models, etc.).

Appendix

Datasets: All datasets come from Copenhagen Municipality.

- cykeldata_kkLine
- BikeRack_10k_KK_2018
- BicycleRamp_marking_10k_KK_2018
- BicycleLane_blue_10k_KK_2015
- SocioEconomicData_statistics_10k_KK_2018
- kvarter_polygon

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Course: Introduction to GIS Lukas Hasler & Sheng Xin Chua