City Liveability Index

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Theoretical Framework

As time goes on the issues of sustainability and liveability have become a greater importance to those living in cities. Issues such as poor air quality, high levels of PM2.5, fine particulate matter, and NO2, nitrogen dioxide, which can cause respiratory and cardiovascular problems (WHO, 2024). Consistent exposure to high noise levels, which can cause cognitive impairment to children (EEA, 2020). A lack of access to green spaces which can lead to an increase in BMI for young children (Wolch et al., 2010). This combined with a lack of public transport leading to increased commuter times can reduce the quality of life for those living in a city. This index aims to evaluate these factors systemically and in doing so provide a framework for assessing and comparing the performance of the capital cities of all European Union nations on the metrics that most effect urban liveability.

Data Selection

For this index I obtained data from three data sources. For environmental factors of a city, air pollution, noise pollution and green spaces, I used data from ISGlobal. The affordability of public transport was sourced from a report made by Greenpeace. Lastly data on public transport usage and the cities own populations satisfaction with a number of issues was obtained from an EU Commision report on the 'Quality of Life in European Cities'.

I chose to work primarily with EU capitals due to the public availability of the data. I would like to extend the index to more cities in the future.

Imputation of Missing Data

I had complete data for most of the indicators I planned on using. The one indicator I didn't was for noise pollution. In the dataset available to me 5 of the 27 EU capitals were absent.

To avoid discarding 5 of the cities in this limited sample, I estimated the values for noise pollution using the *k Nearest Neighbours* algorithm. This works by determining the most similar cities, from the other data points, and filling in the missing noise pollution value based off those similar cities.

Multivariate Analysis

Through multivariate analysis I was able to determine that most of my indicators fell between –0.66 and 0.71, which is not a concern. There is one pair of values, satisfaction

with the noise level and satisfaction with the air quality, that were very highly correlated at 0.95. To avoid including two highly correlated values, I used PCA, principal component analysis, to reduce the dimension of these values into a single value.

Normalisation

To compute the missing noise values, I was required to normalise the data. I used the min max method. This scaled the data to values from 0 to 1, where 0 is the lowest value in an indicator and 1 is the highest value.

Weighting and Aggregation

My data is divided up into 4 sub-indices, Environment Quality, Mobility and Transport, Public Perception and Satisfaction Living in the City.

Environment Quality Index

The Environment Quality Index includes the following values, annual mean $PM_{2.5}$ levels, annual mean NO_2 levels, percentage of a city that is green space, and percentage of the population exposed to >55 dB L_{den} (day-evening-night level a European standard to express noise levels throughout the day).

The air pollution and noise pollution levels were inverted to be negative; these have a harmful effect on the population's health. The percentage of green spaces was left as positive.

For the weights in the sub-index, I used equal values, 0.25, as each can be harmful to a person's health. While air pollution is the most harmful out of the values here, it is represented twice through two different measures.

Mobility and Transport Index

The Mobility and Transport Index includes the following values, the percent of people that travel in a day most often by, private vehicle (car and motorbike), bicycle, foot, public transport (train, bus, metro, tram), other, and the affordability scores given to each city in a Green peace report.

The use of private vehicles was inverted to be negative; a high use of private vehicles can negatively impact the lives of the city's residents. All other values remained positive.

Those you often travel by 'other' was weighted lower than other values at 0.1. The rest of the values were weighted equally, 0.18.

Public Perception Index

The Public Perception Index includes the percentage of the public satisfied with, public transport, green spaces and the combined noise and air pollution value.

All these values were kept positive as each represents how positively a person views their city in these aspects.

Each value was also weighted equally.

Satisfaction Living in the City

This value encompasses both the individual values contained in the Public Perception Index as well as other factors that make up like in a city. Such as dealing with local government, job availability, housing availability and safety.

As this is a single value no weighting was required.

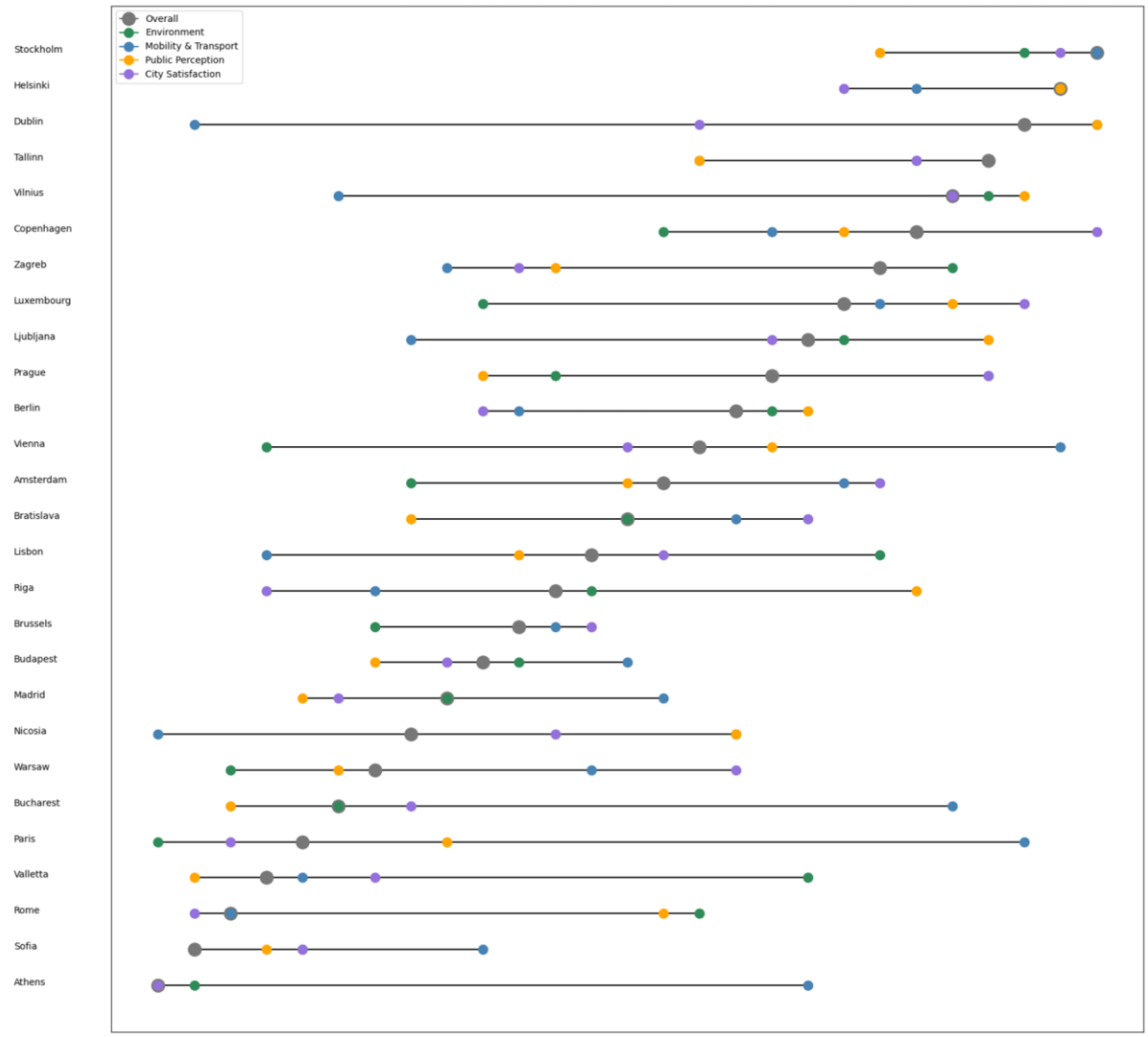
City Liveability Index

To make up the composite City Liveability Index the sub-indices are weighted as follows; Environment Quality Index 0.35, Mobility and Transport Index 0.35, Public Perception 0.2, Satisfaction Living in the City 0.1.

The Environment Quality and Mobility and Transport Indices contain more objective information than the Public Perception and Satisfaction Living in the City Indices. The Satisfaction Living in the City Index was weighted lower as it considers many broad factors about city life, that are not directly relevant to this index.

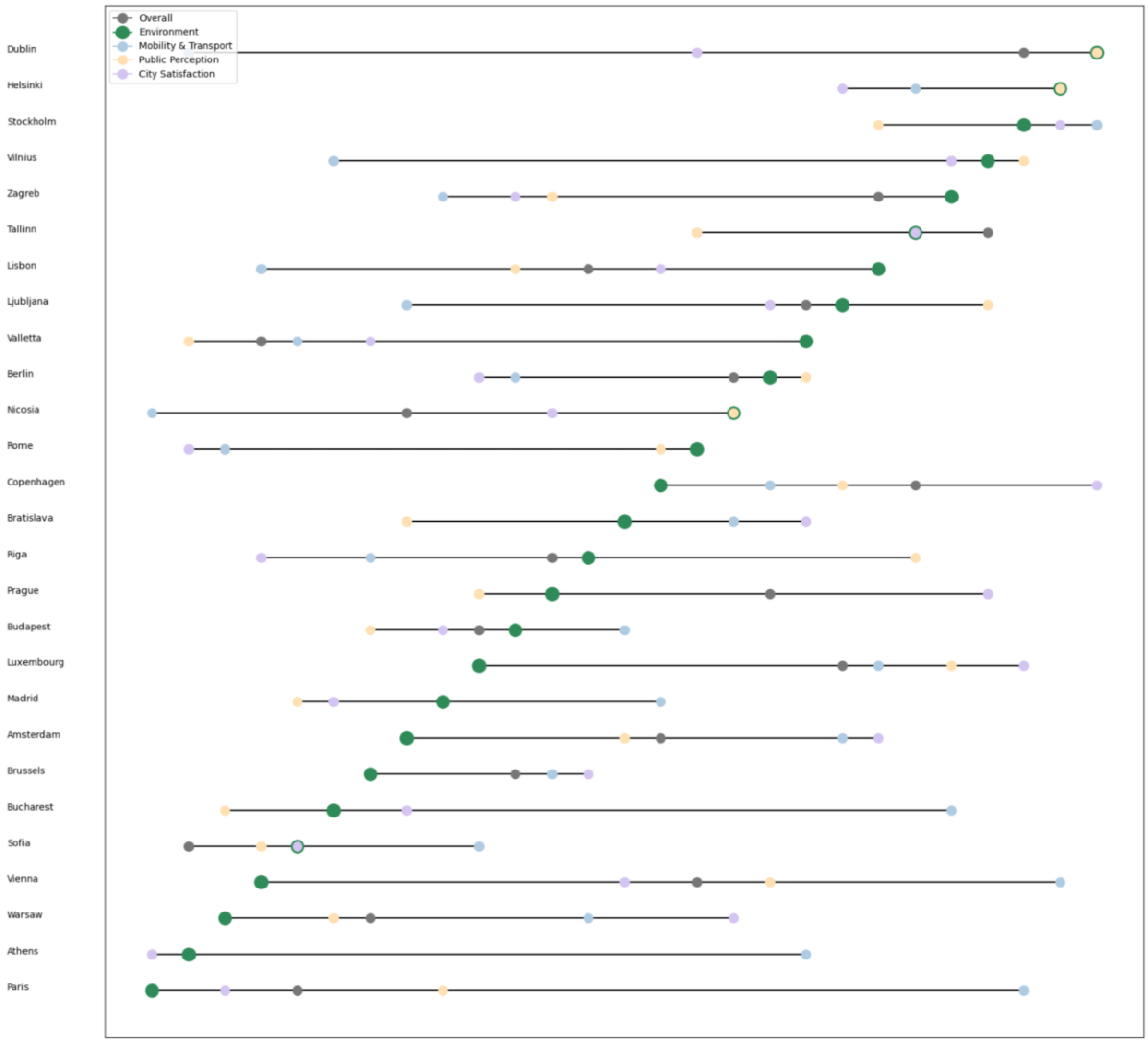
Visualisation of Results

City Liveability Index



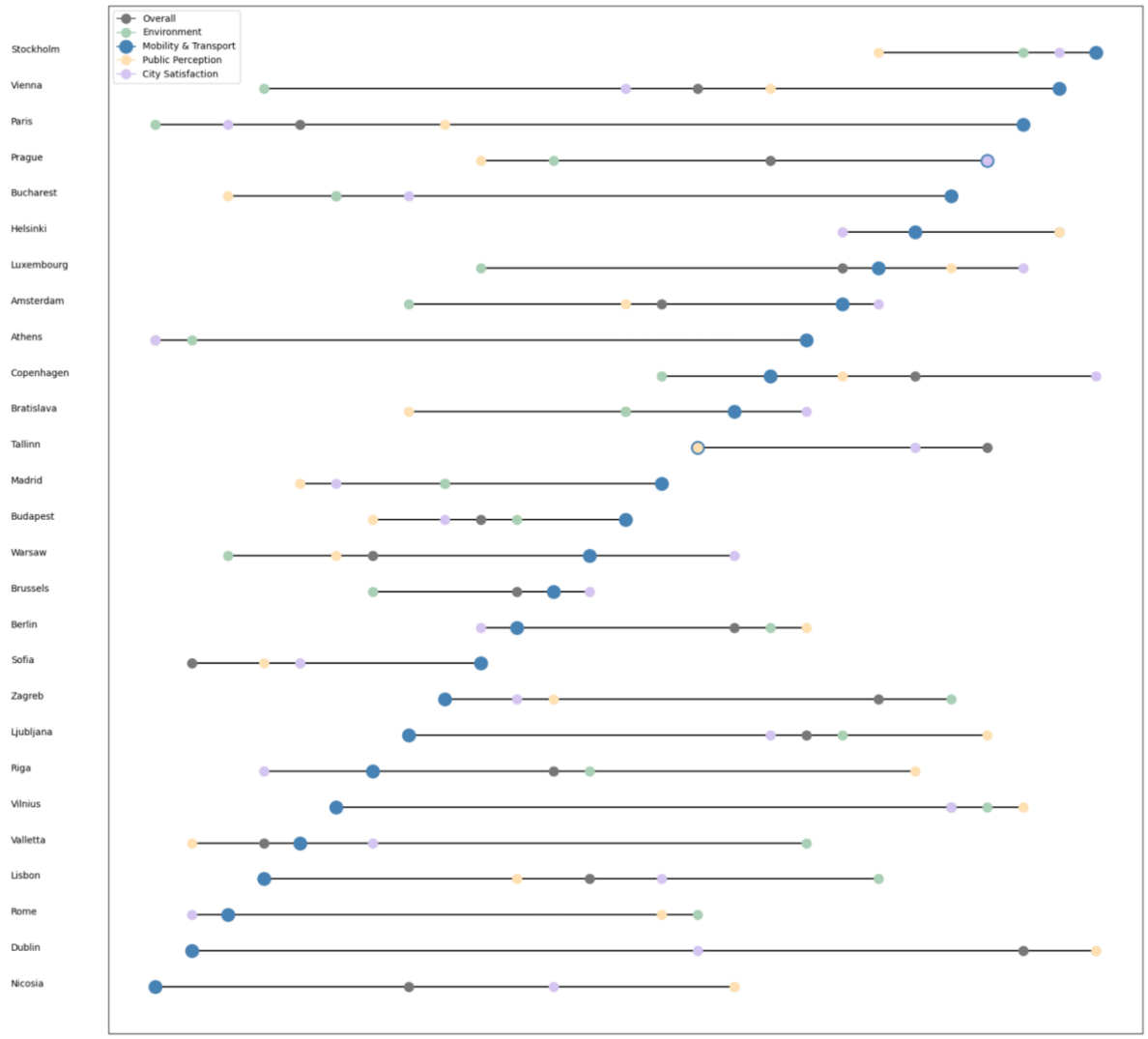
This chart ranks the cities by their overall position in the composite City Liveability Index. How the city ranks in other categories can also be seen. A large gap between points indicates a large difference in the city's ranking in each index.

Environment Quality Index



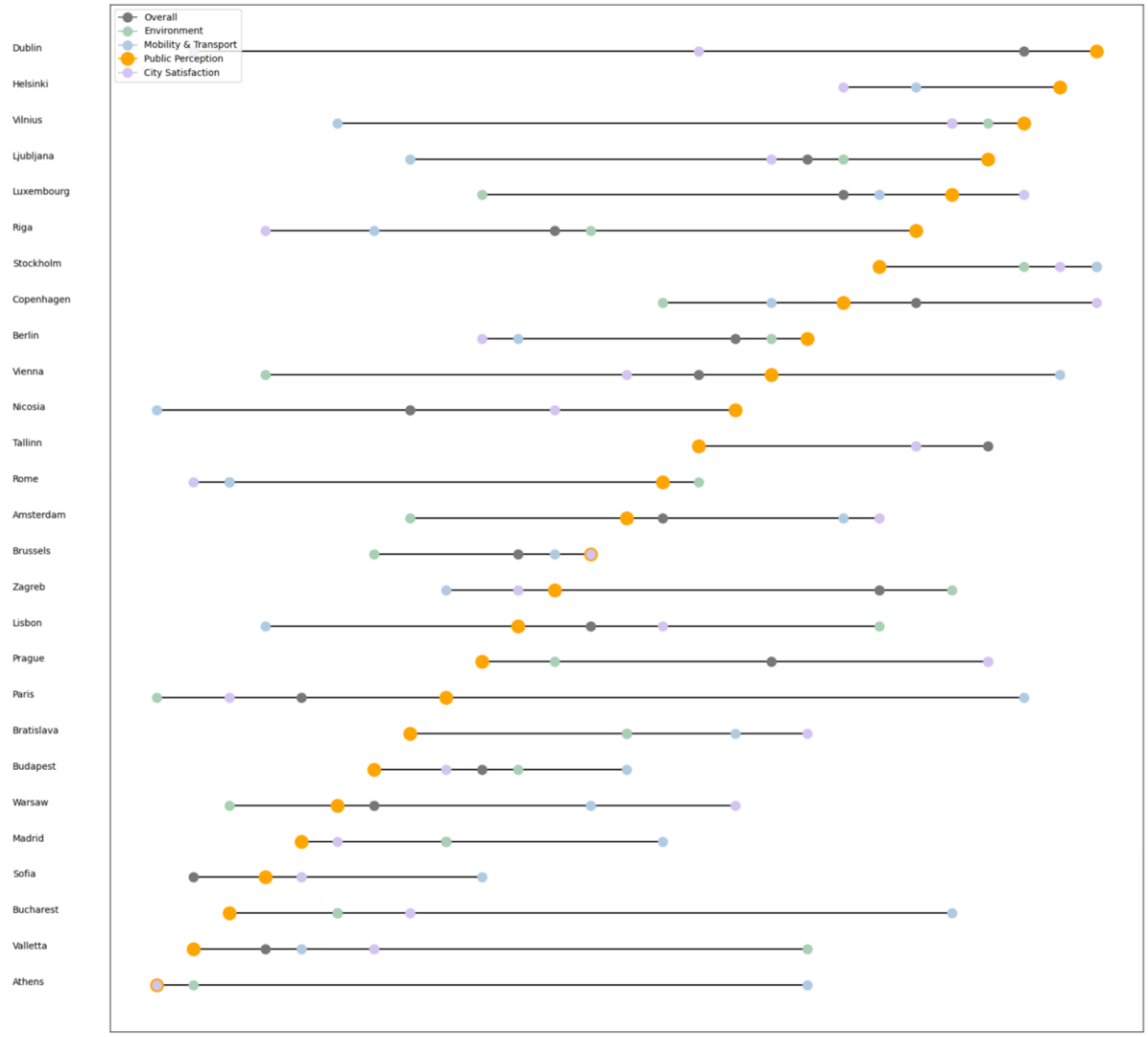
In this chart the cities are shown in order of their position in the Environment Quality Index. Other rankings are visible but muted to highlight the current index.

Mobility and Transport Index



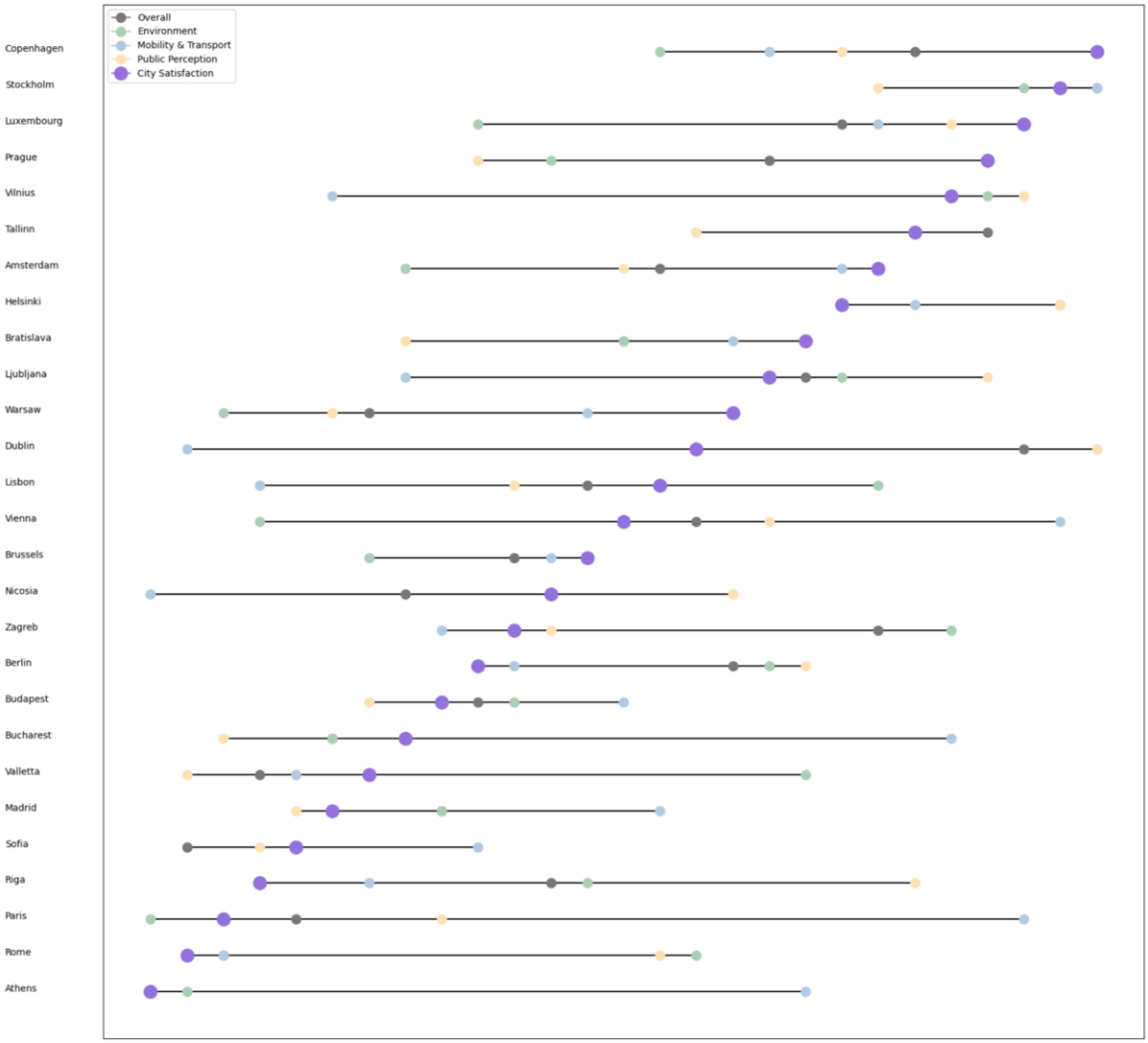
In this chart the cities are shown in order of their position in the Mobility and Transport Index. Other rankings are visible but muted to highlight the current index.

Public Perception Index



In this chart the cities are shown in order of their position in the Public Perception Index. Other rankings are visible but muted to highlight the current index.

Satisfaction Living in the City Index



In this chart the cities are shown in order of their position in the Satisfaction Living in the City Index. Other rankings are visible but muted to highlight the current index.

Comparison to other Indices

When compared to the Arcadis Sustainable Cities Index 2024 there are some similarities. The Planet Pillar sub-index covers some similar data to that measured in the Environment Quality Index, air pollution and green spaces. The People Pillar sub-index has a small cross over with the Mobility and Transport Index, each looking at public transport. There is no crossover between the Profit Pillar sub-index and the Public Perception and Satisfaction Living in the City indices, other than a small part of the Satisfaction Living in the City Index being made up of considerations around jobs and economic development. The Progress Pillar which is a comparison to previous Arcadis Sustainable Cities Indices has no comparator in my City Liveability Index.

The number one ranked city in the Environment Quality index places 37th on Arcadis' Planet Pillar, behind several other EU capitals. Dublin does get a highlighted mention for its strength in air pollution. This makes up a greater proportion of my Environment Quality Index which may explain some of the difference. Other EU capitals place in similarly disparate positions between the two indices, such as Copenhagen that places as the top EU capital and number two in the Planet Index, places 13th in the Environment Index.

The People Pillar places Paris and Vienna in 1st and 2nd, which does compare favourably with the same cities placing at 3 and 2, in the Mobility and Transport index. This is likely due to coincidence, due to the small crossover in factors considered.

The overall Sustainable City index places Stockholm and Dublin in the top 15, which are at number 1 and 3 on the City Liveability Index. But other EU capital cities in the top 15, Copenhagen, Berlin and Warsaw place at 6, 11 and 22.

Appendices

GitHub: https://github.com/Mayv-dev/LivableCitiesIndex

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