Cartography M.Sc.

# GETTING THERE IS HALF THE FUN

## Intermodal Transport Comparison of the Cities of AMS and BLR!

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# Roadmap

- Introduction and Motivation
- Research Idealogy and Aims
- Understanding the concepts of Navigation, Gaps and Patterns
- Study Area and Elements
- Patterns highlighted by the Space Time Cubes
- Gaps highlighted by data visualisations
- User Perspectives
- Results
- Discussion and Challenges

# Introduction and Motivation

Navigation is a complex system comprising interconnected elements that impact our mobility.

Studying navigation patterns in different urban environments can help understand overall efficiency, and ways of how to improve them.

**Motivation:** Understanding how and why a route of similar kilometre level performs completely differently in different cities and what are the factors that influence the time delays.

The patterns these delays highlight are the key learnings that can help with understanding where and how the city's navigation system can be improved and to what extent.

# Research Idealogy

Comparing dissimilar cities allows for cross-learning, innovation, and adaptable urban planning and transportation policy strategies.

Amsterdam

Bengaluru

European cities, known for integrated transport systems, can serve as benchmarks for Indian cities, aiding in understanding effective methods and reducing private vehicle reliance.

Comparing these cities provides insights for potential benefits in Indian smart cities like Chennai, Dharwad, Delhi, Mumbai, Hyderabad, Lucknow, Kolkata, and other developing Asian cities with a good transit network.

# Research Aims

1

### PATTERNS

How can space-time cubes be used to identify differences in urban infrastructure, such as traffic delays, travel times, and transportation accessibility, including last-mile connectivity?

2

### TIME AND SPACE

How might data visualisations such as space-time cubes be used to compare and map the transport infrastructure of two cities?

3

### GAP ANALYSIS

To what extent do the gaps explained in the Gaps section exist in cities of India like Bengaluru, and to what extent do the observed changes in the systems persist in more developed cities like Amsterdam?

4

### DATA VISUALISATIONS

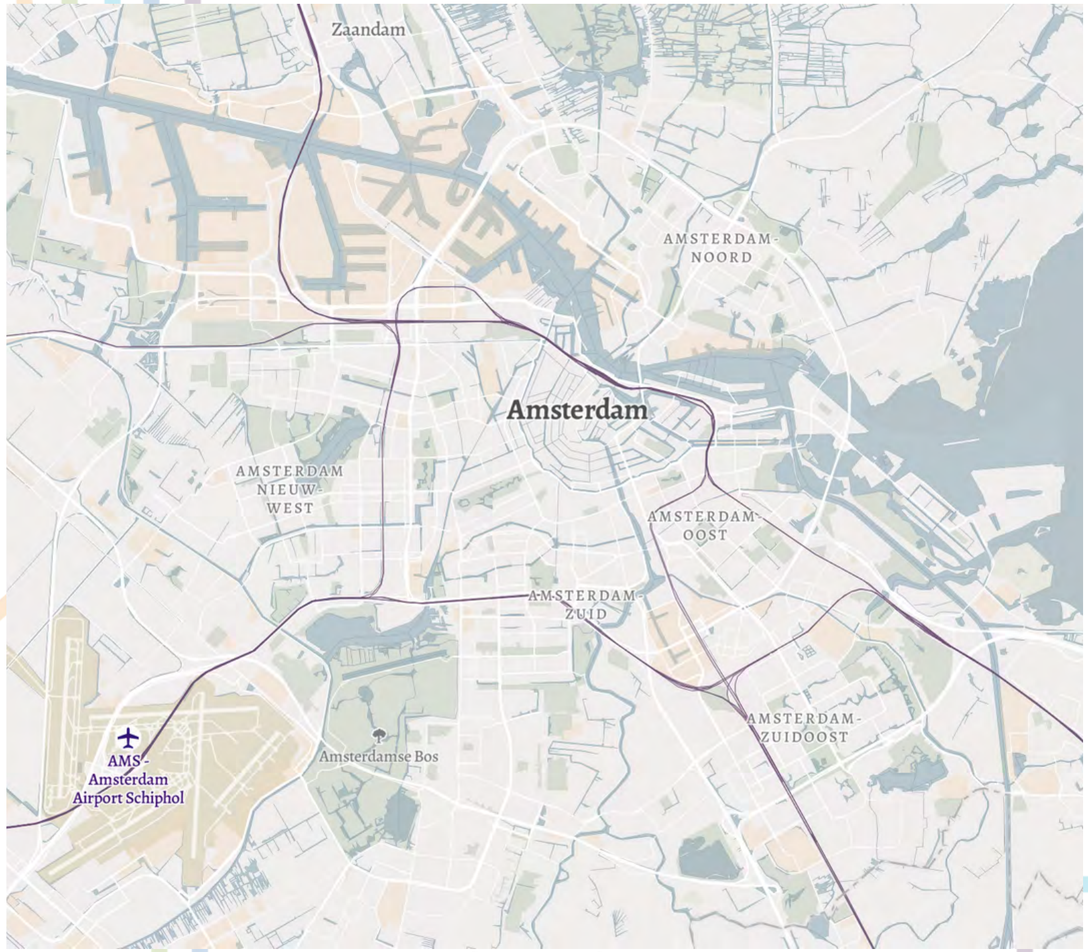
How do time and space factors differ between the two cities, and what implications might these differences have for the design and improvement of transport systems?

5

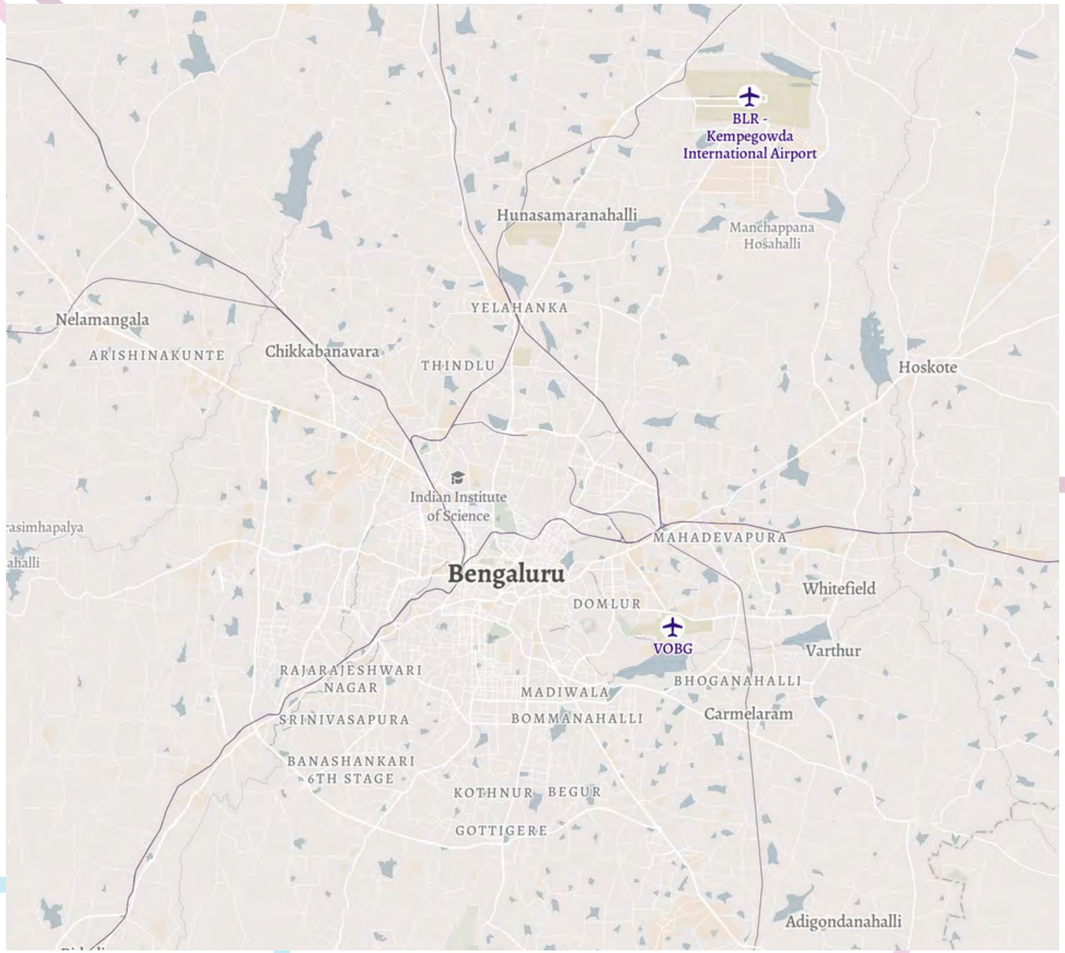
### TRANSPORT MODELS

Finally, can one city's navigation system be used to help build or improve another city's transport network, and to what extent

# Study Area and Elements




**Amsterdam Urban Area**
Map Scale: 1:500,000 - 76.437 meters/pixel
Style: Mapbox @bepoorni
Area: 219.32 sq km
Population: 1,174,000 (urban area)




**Bengaluru Urban Area**
Map Scale: 1:500,000 - 76.437 meters/pixel
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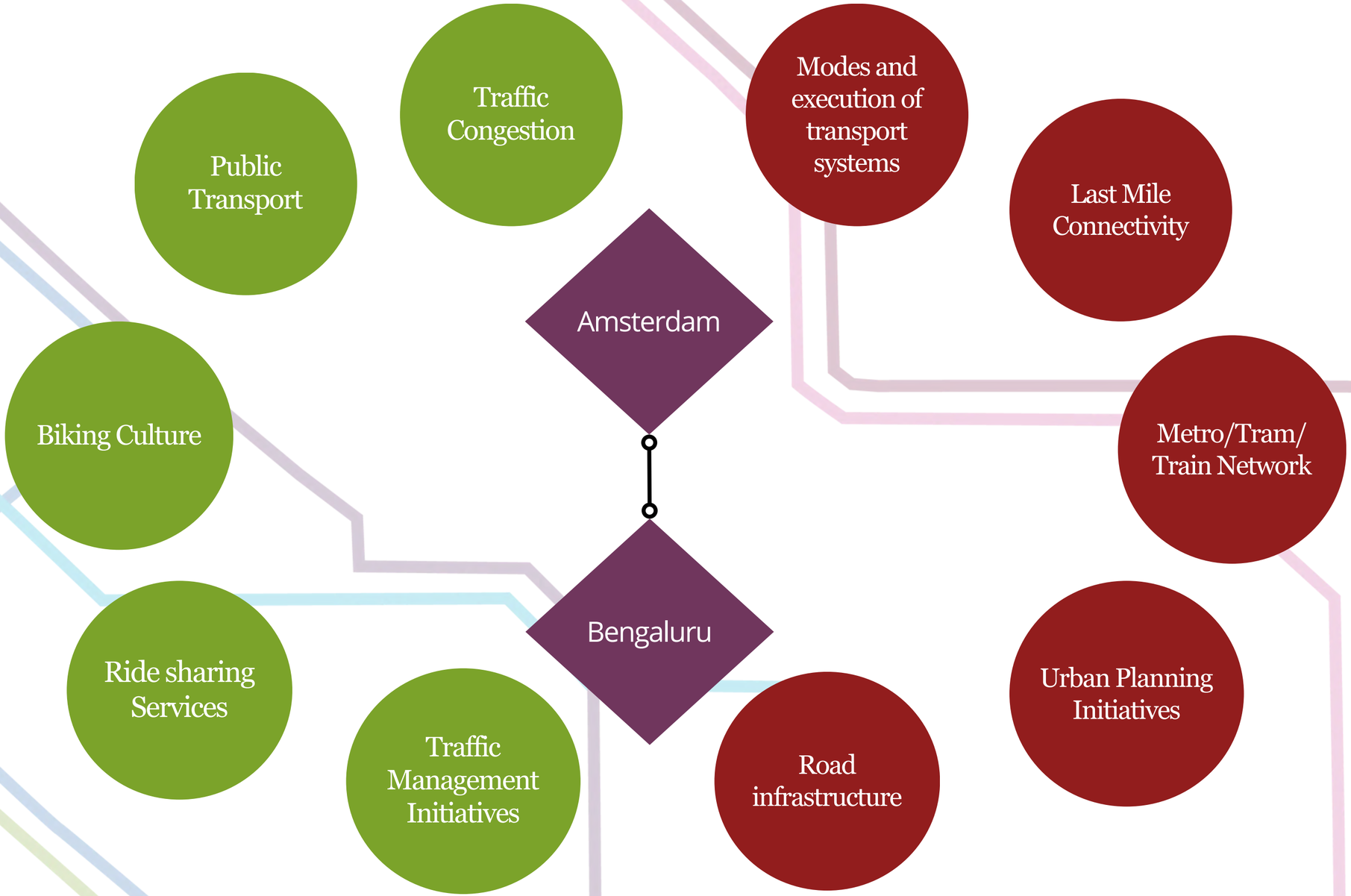
Area: 709 sq km
Population: 13,608,000 (Urban area)

# Similarities and Differences



# Data and the Introduced Bias

The analysis differs from existing data methods. While available data, like bus routes and train networks, is used for visualising existing transport networks, personally collected data is employed to assess time factors by physically identifying gaps in these routes.

This research tries to combine two perspectives

- Researcher Perspective
- User Perspective

Route network data for BLR is procured from:

- BMTC
- BMRCL
- OpenStreetMap-Overpass
- Bangalore OpenCity
- Geohacker's BMTC Visualisation

Route network data for AMS is procured from:

- GVB
- OpenStreetMap-Overpass
- Netherlands OpenData

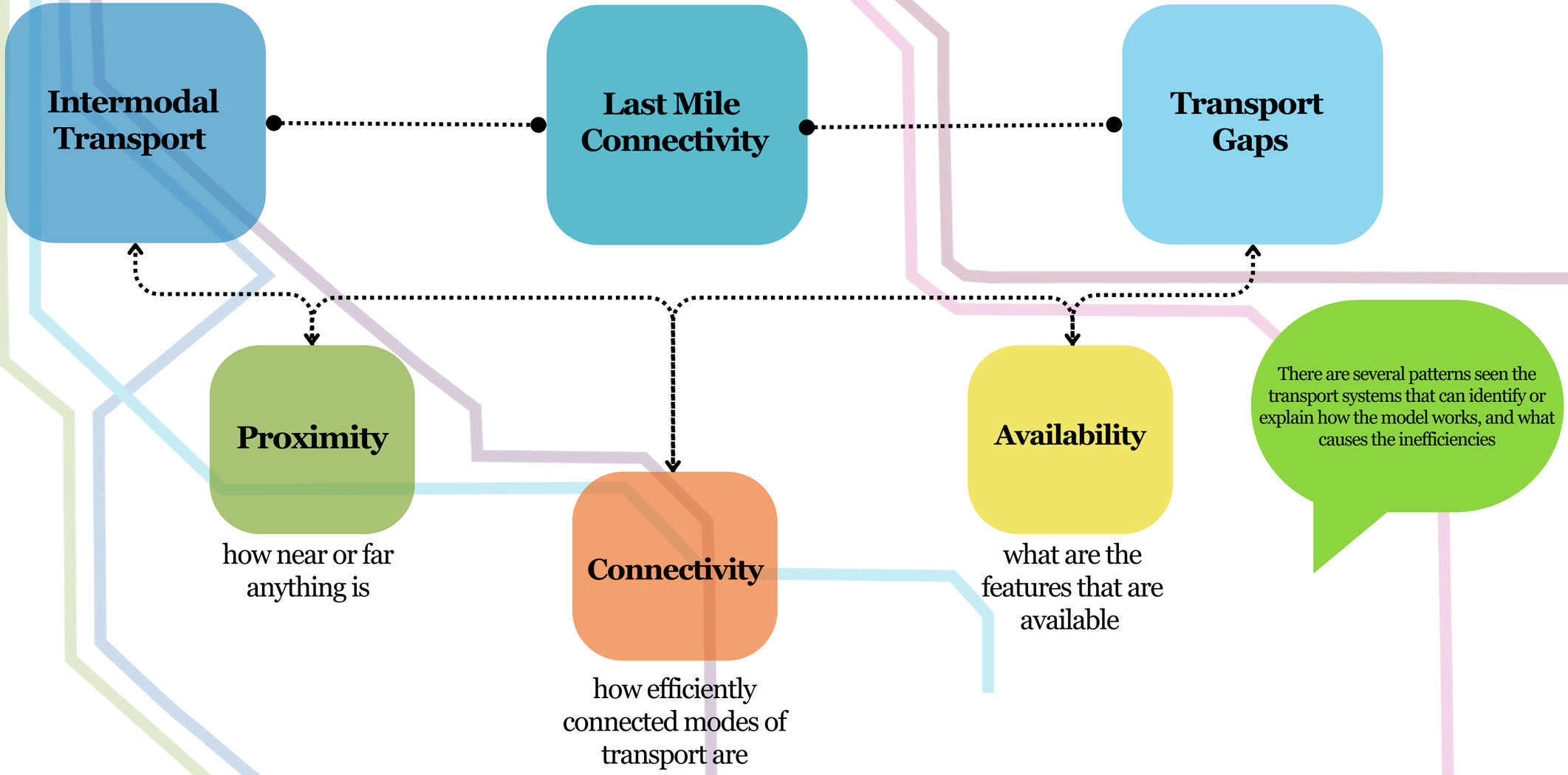
These data points are chosen to provide an encompassing view of the city's transportation efficiency. The following categories of data points are included:


100 data points for each city

Efficiency in a city's transport network doesn't only hinge on its central locations. It relies on the connectivity of even the farthest neighbourhoods to all the city's amenities.

# Concepts of Navigation and the Patterns

This research focuses on three concepts of navigation:



# Understanding the Gaps

A gap signifies a notable difference or deficiency between two points, concepts, or entities, emphasizing a need for improvement or alignment.

This gap is crucial in assessing public transport efficiency, as it highlights the overreliance on private vehicles for last-mile connectivity.

- Lack of integration
- Lack of efficient transport methods
- Insufficient infrastructure for pedestrians and cyclists
- Limited accessibility
- Lack of realtime information
- Crowds and Delays
- historic architecture and old infrastructure

# Mobility Indicators

When checking the health of the transport infrastructure, the usual indicators to check are -->

The focus of gap analysis here public tranportation, road network, pedestrian infrastructure and accessibility.

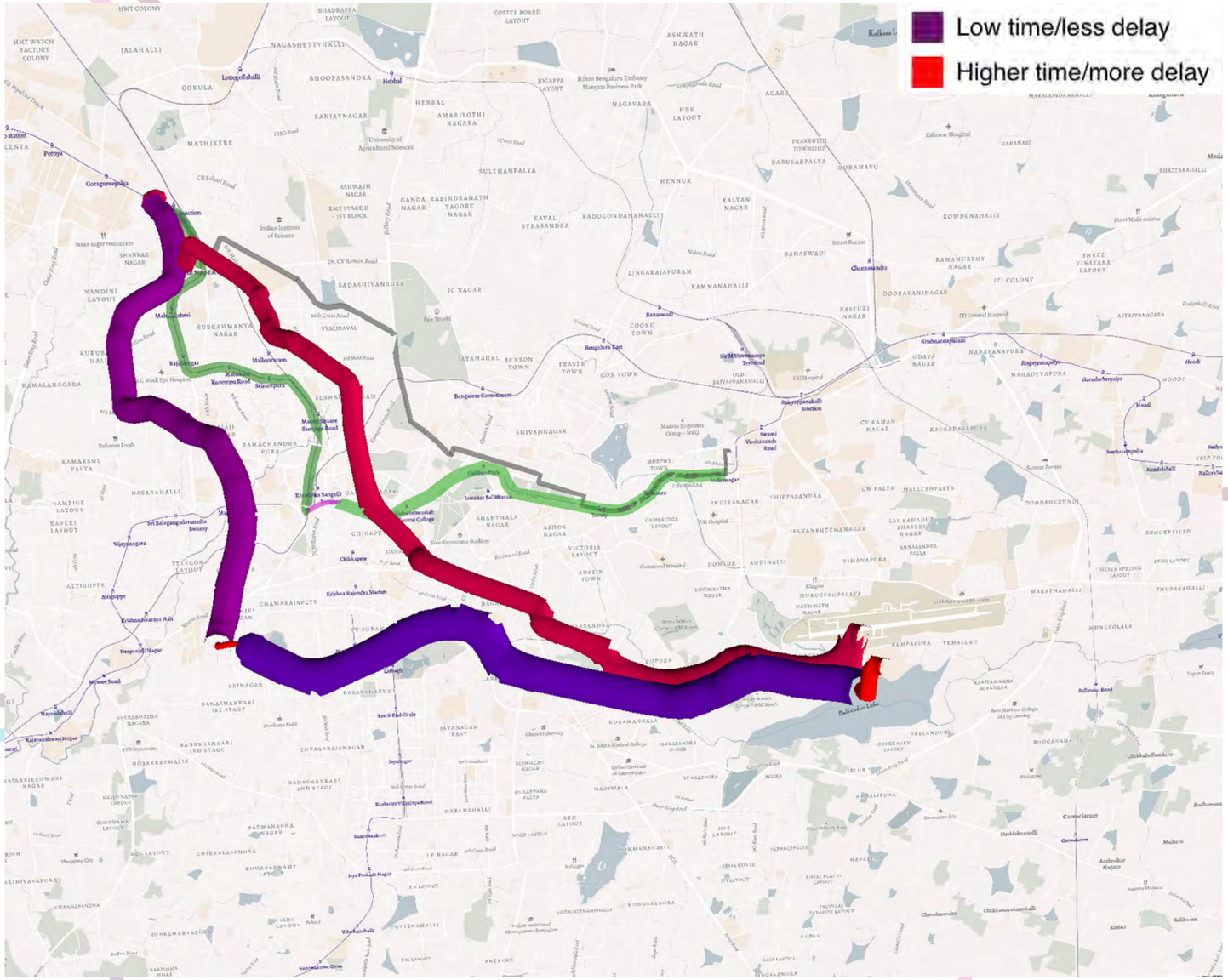
- Public Transportation
- Road Networks and Traffic
- Pedestrian Infrastructure
- Accessibility to Key Destinations
- Transportation Equity
- Smart Mobility Solutions
- Biking Infrastructure

# Patterns using Space Time Cubes

## Comparative Factor: Time

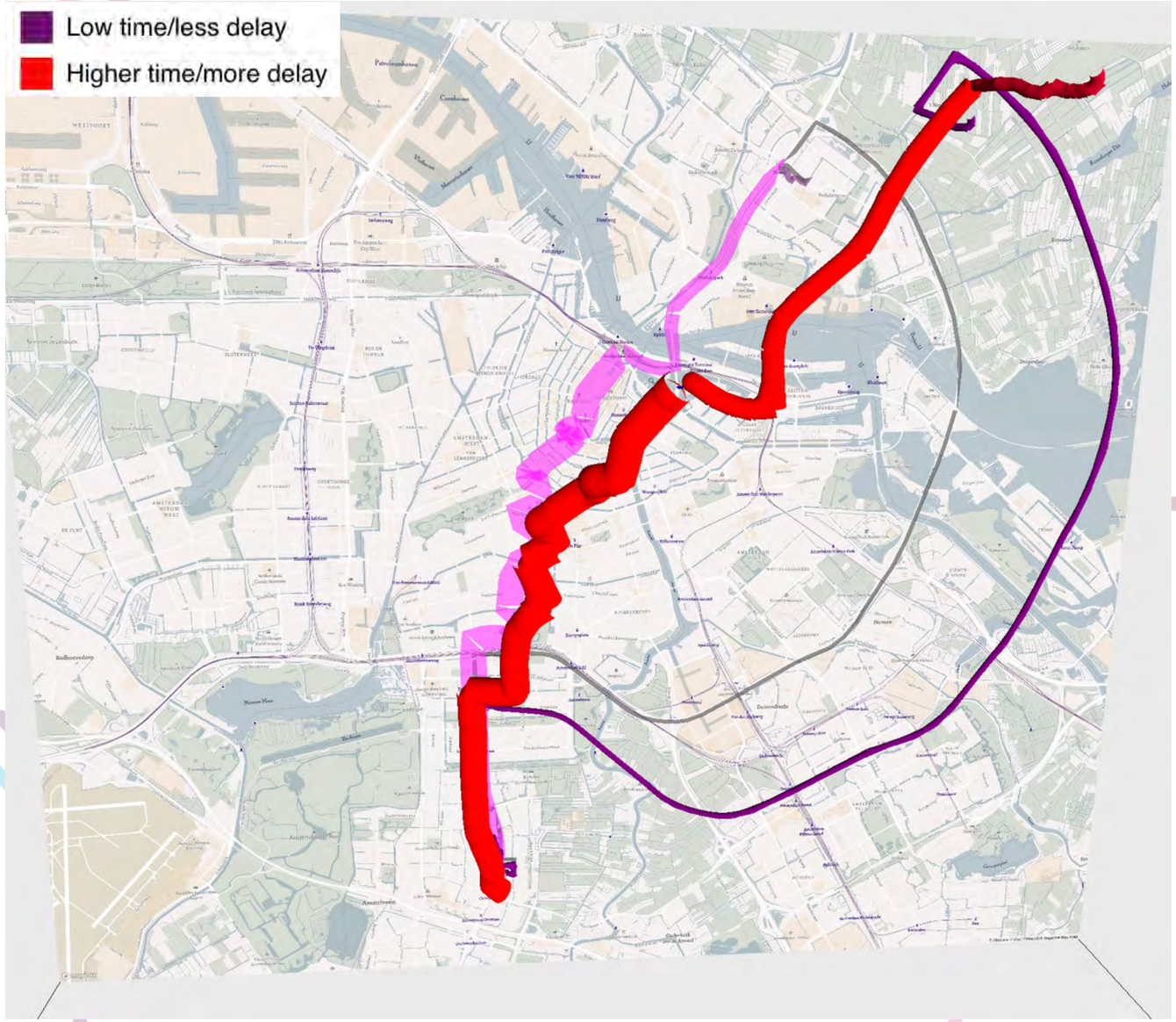
# Bengaluru

**Route**: Yeshwantpur to Domlur
**Kilometres**: 18.2 (PT), 18.4 (Driving)
**Modes of transport**: Driving and Metro Trains
**Time in minutes**: Driving: 80 | Metro: 38.
**Route Hour**: Peak Hour



# Amsterdam

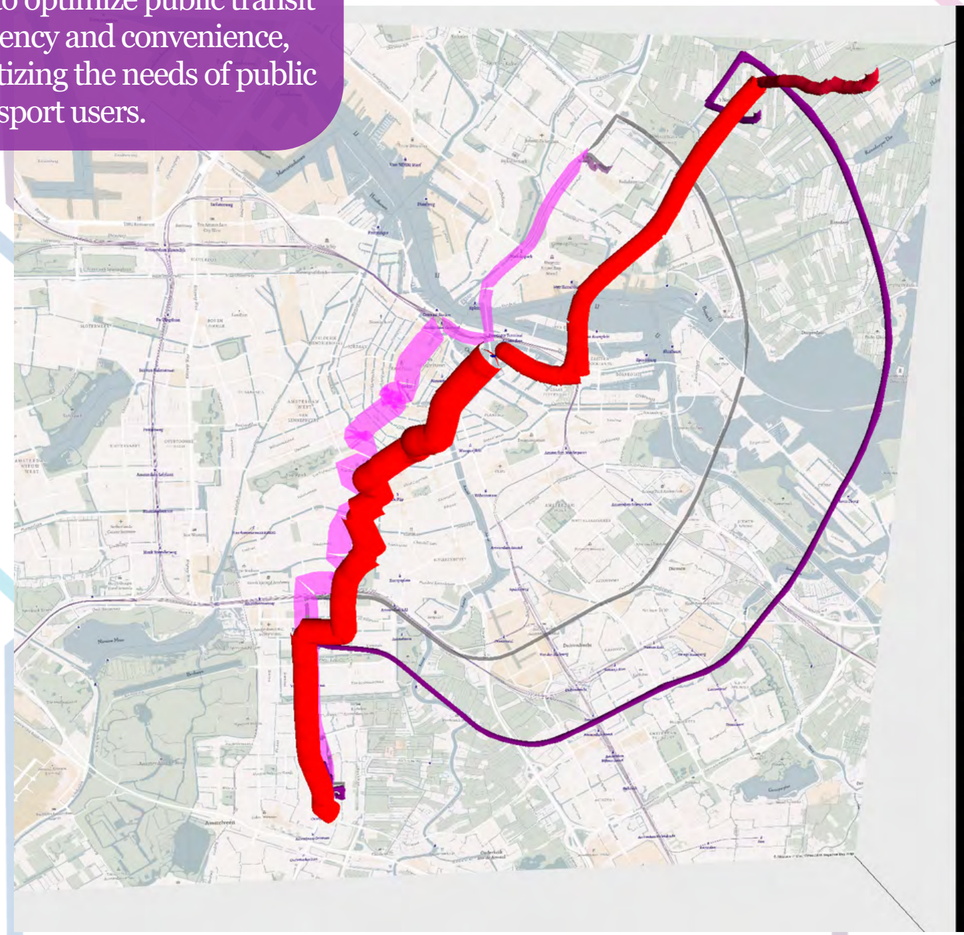
**Route**: Amstelveen to Amsterdam Noord
**Kilometres**: 18.4 (PT), 24.2 (Driving)
**Modes of transport**: Driving and Metro Trains
**Time in minutes**: Driving: 20 | Tram/Metro: 40.
**Route Hour**: Peak Hour

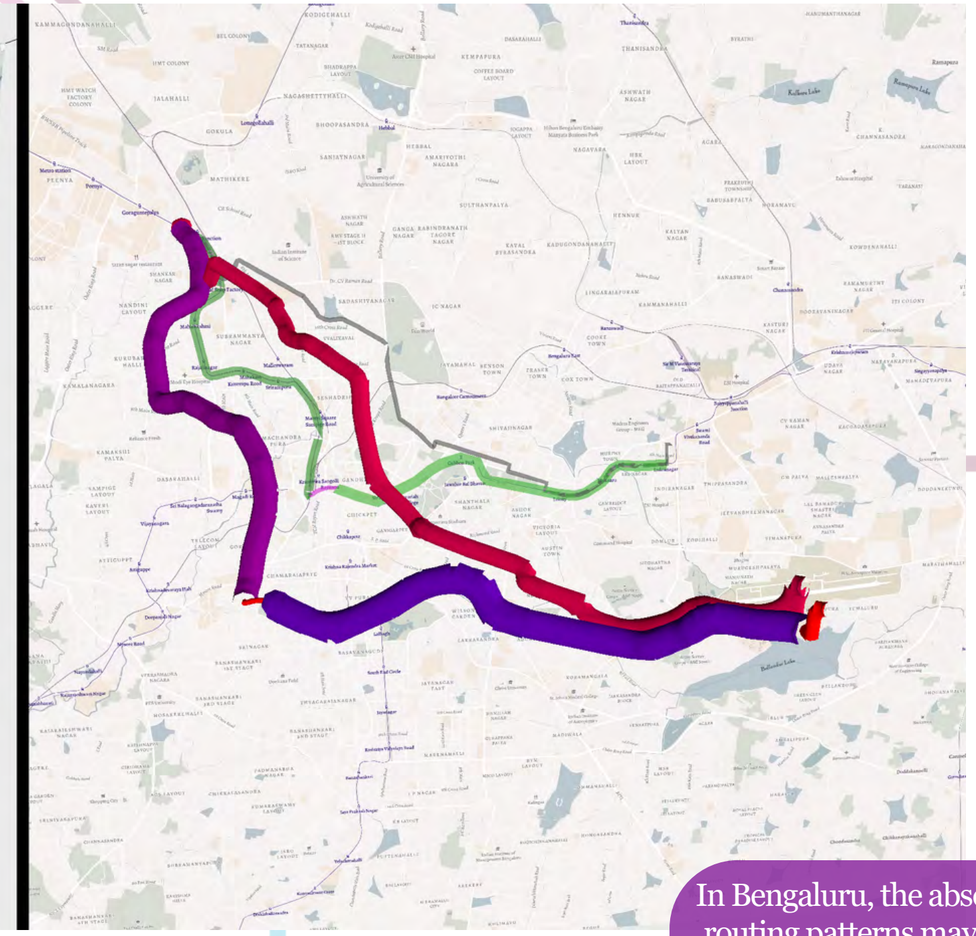


Amsterdam's approach suggests a deliberate effort to optimize public transit routes for efficiency and convenience, potentially prioritizing the needs of public transport users.

Low time/less delay

Higher time/more delay



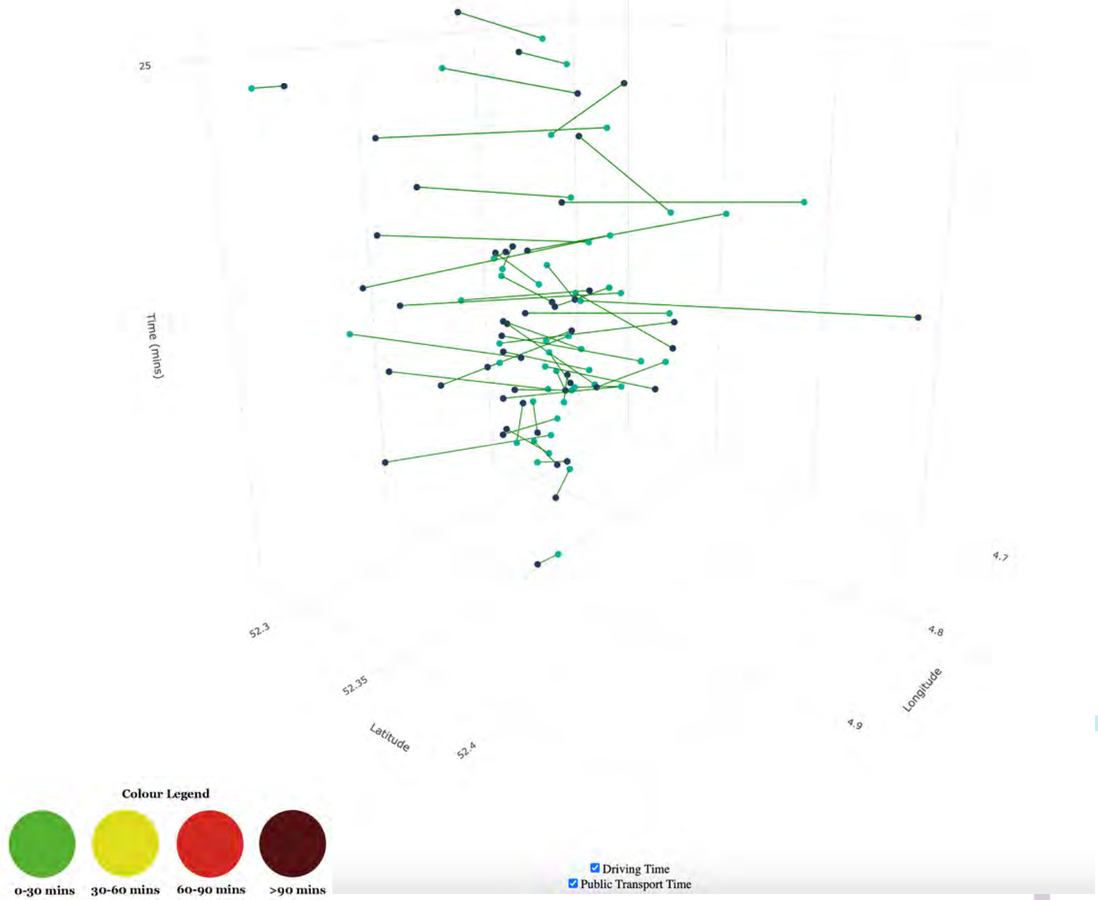


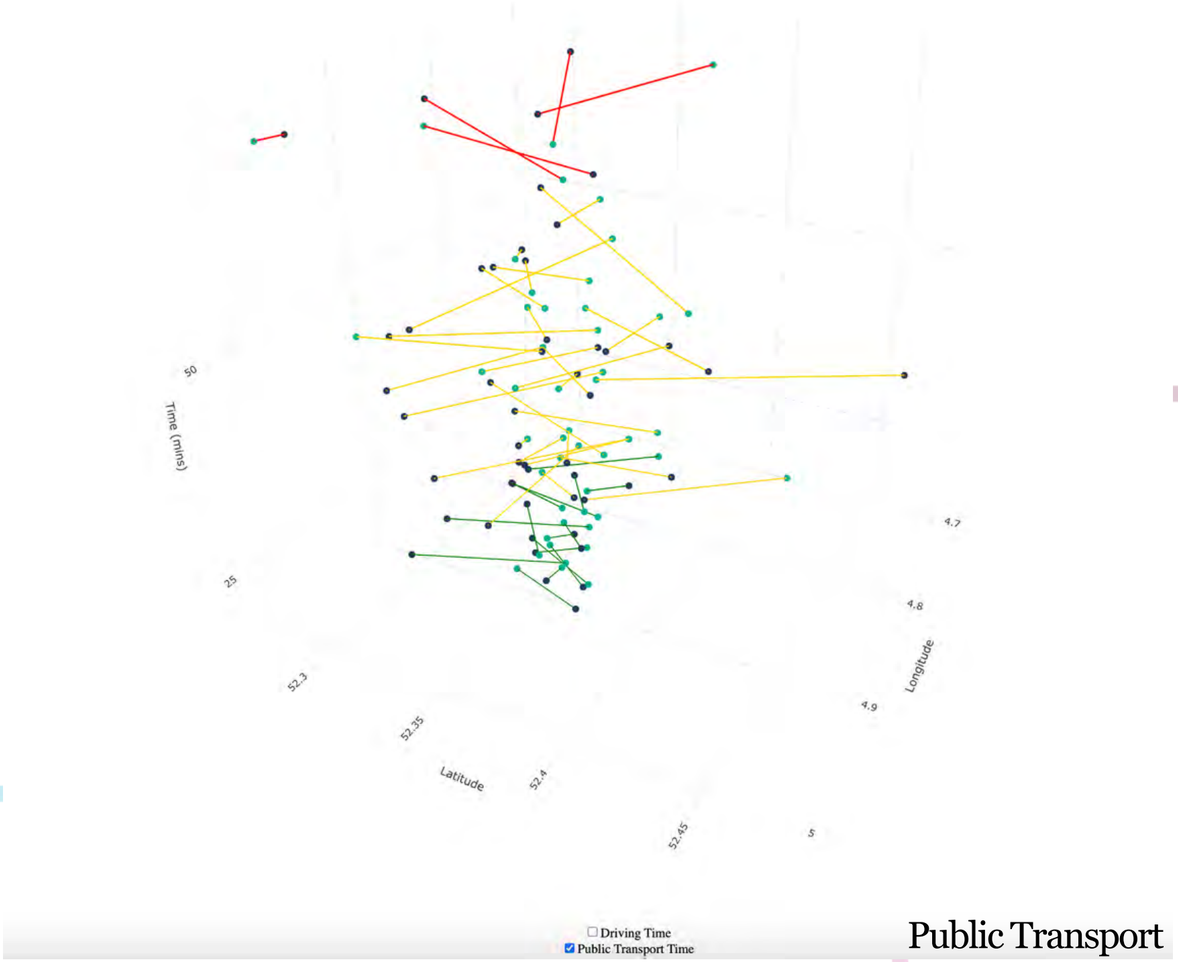
In Bengaluru, the absence of such distinct routing patterns may indicate a different emphasis on transportation planning, where public transit shares roadways more closely with other forms of transportation.

# Space-time Cubes' Understanding of the Transport Spread

# Amsterdam - Non Peak hour

Driving

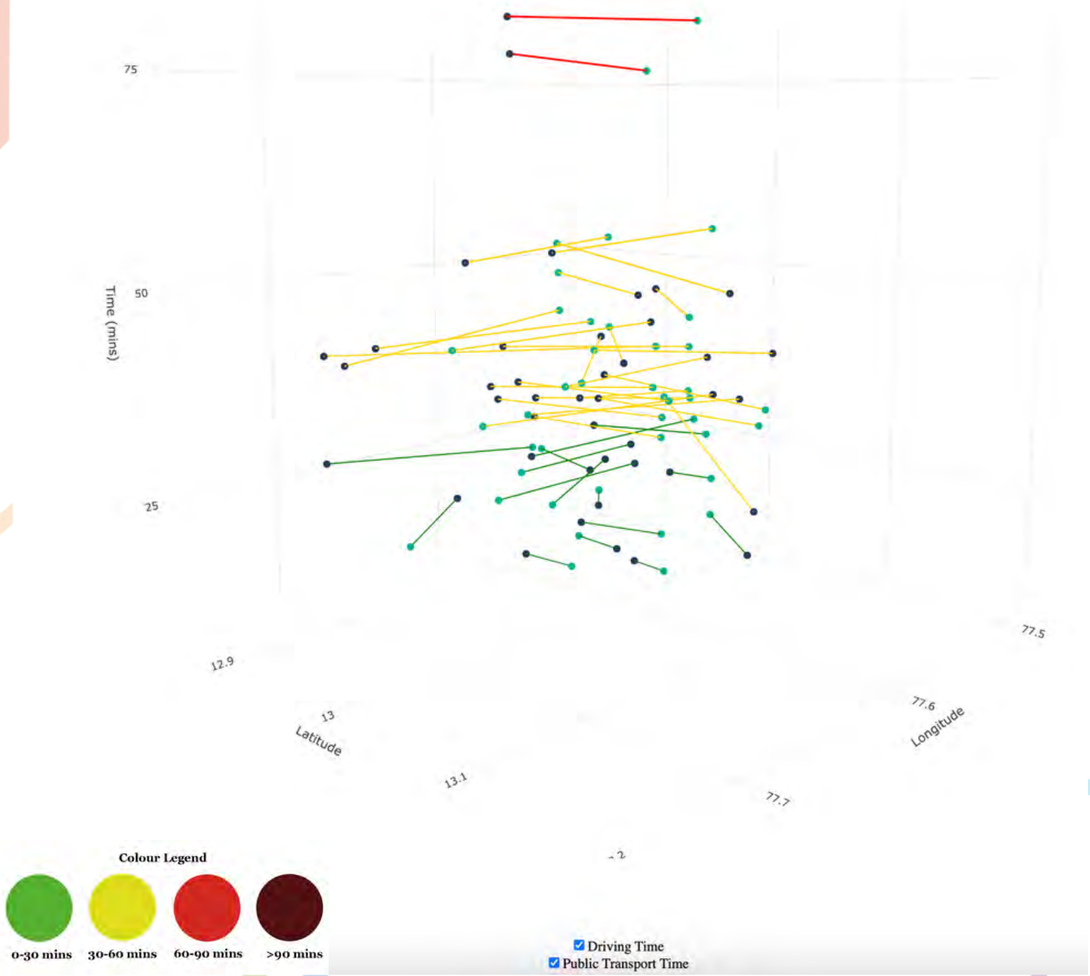


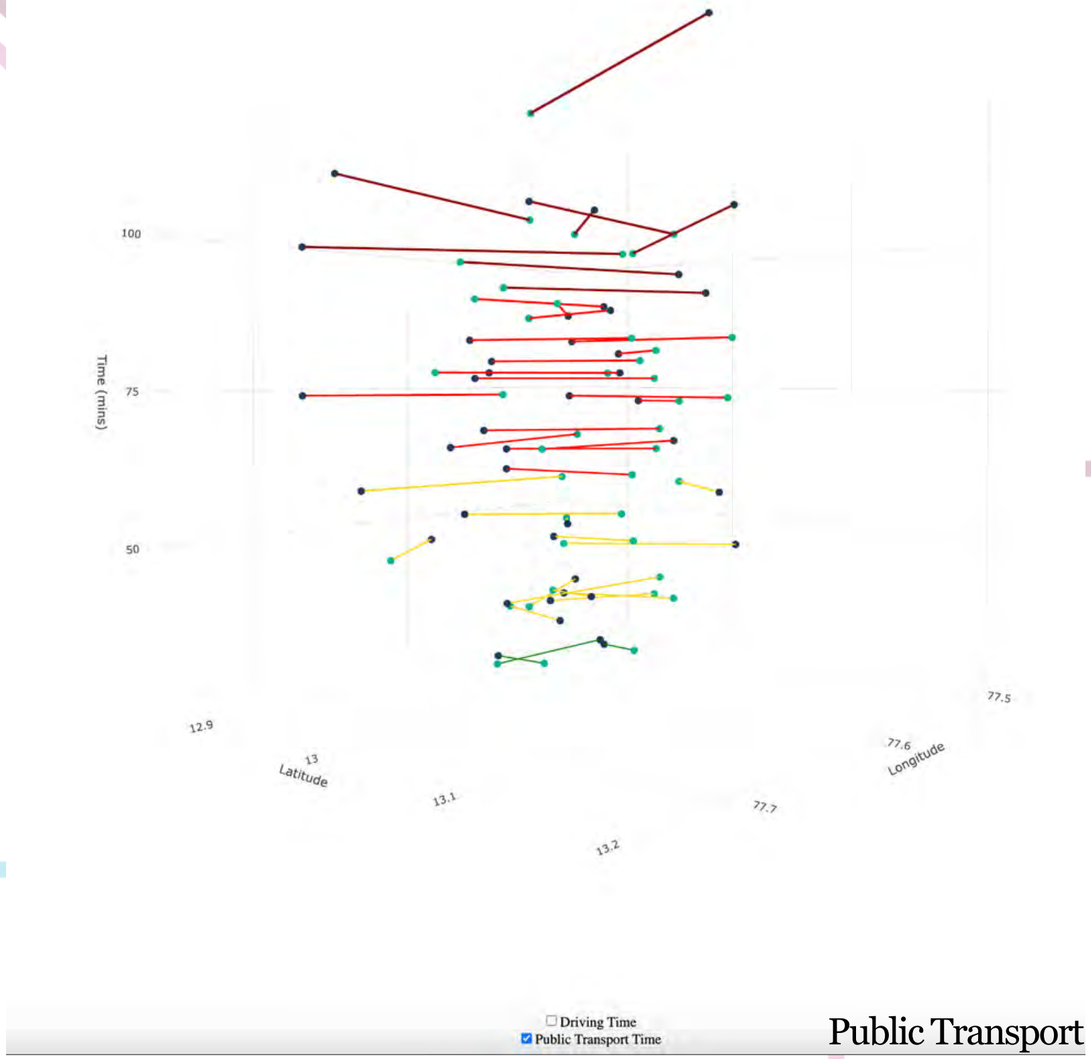




Public Transport

# Bengaluru - Non Peak hour

Driving

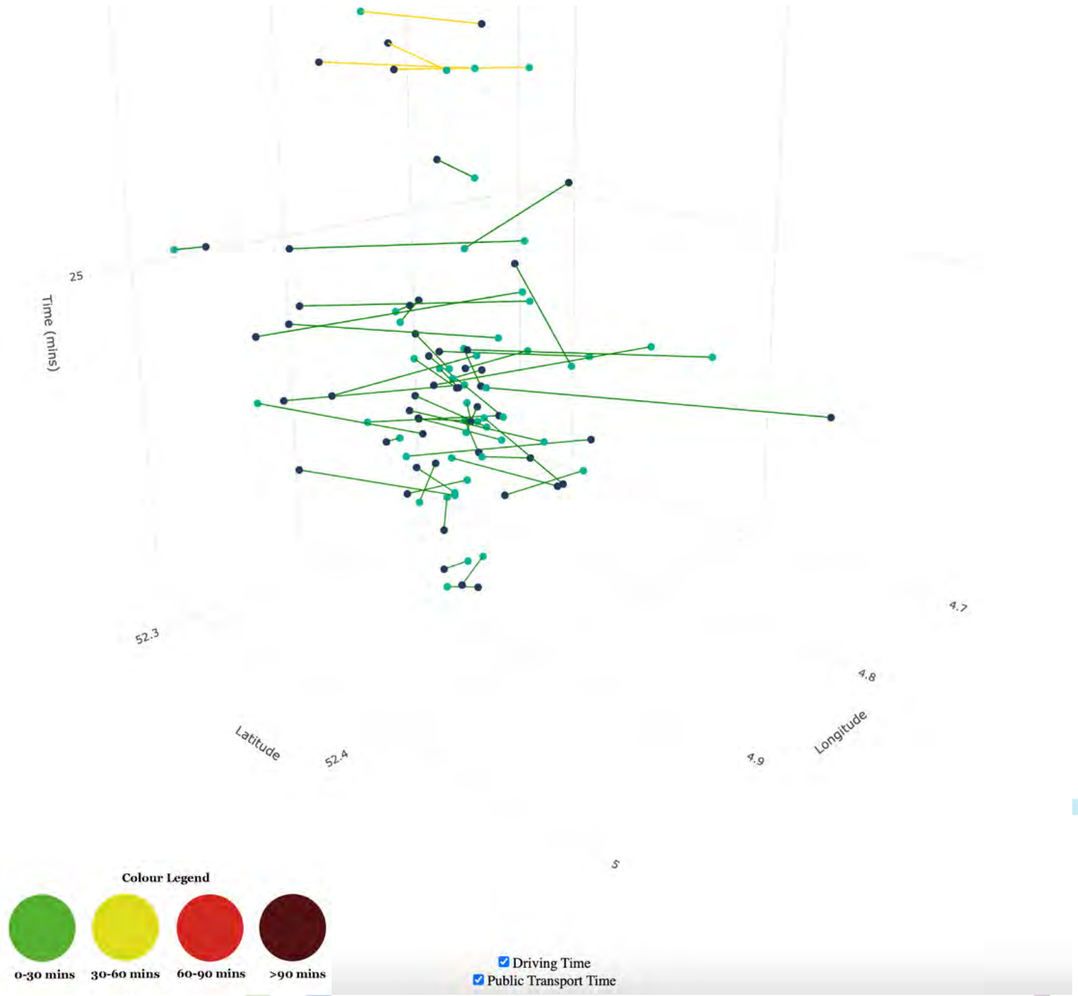


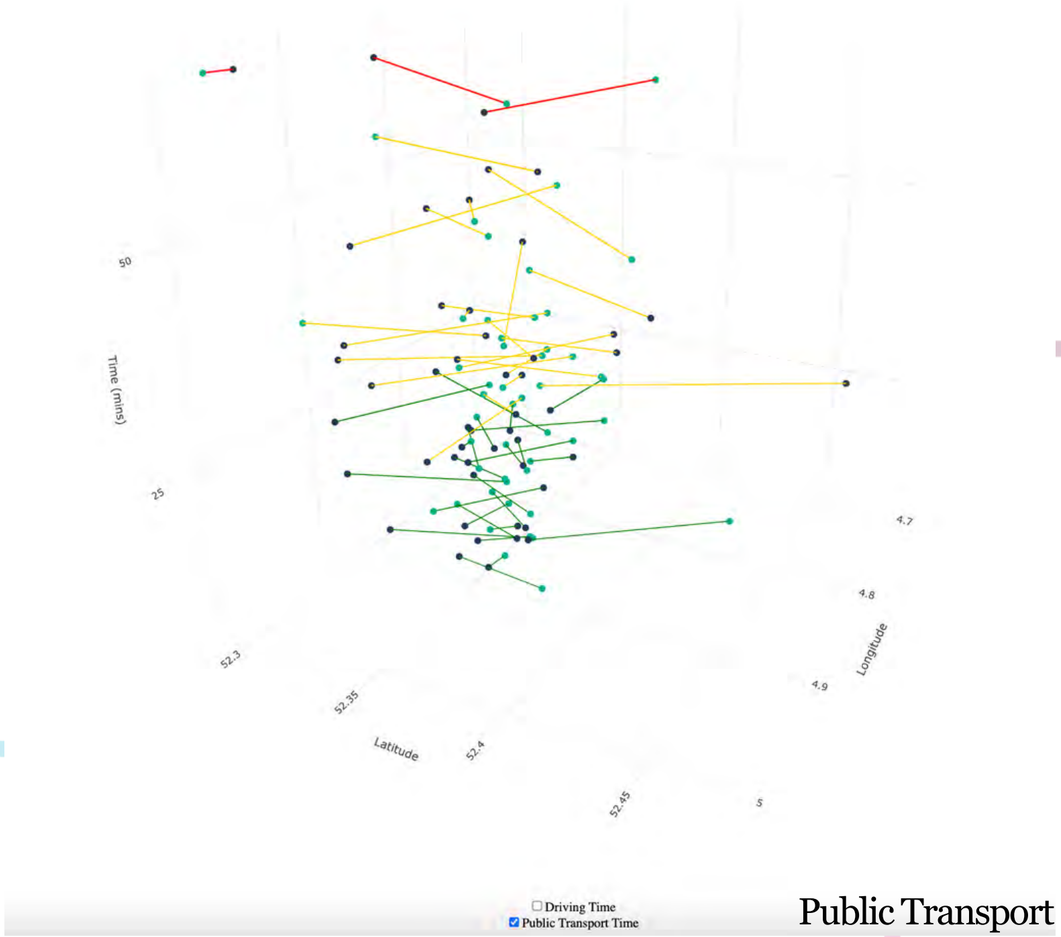




Public Transport

# Amsterdam - Peak hour

Driving

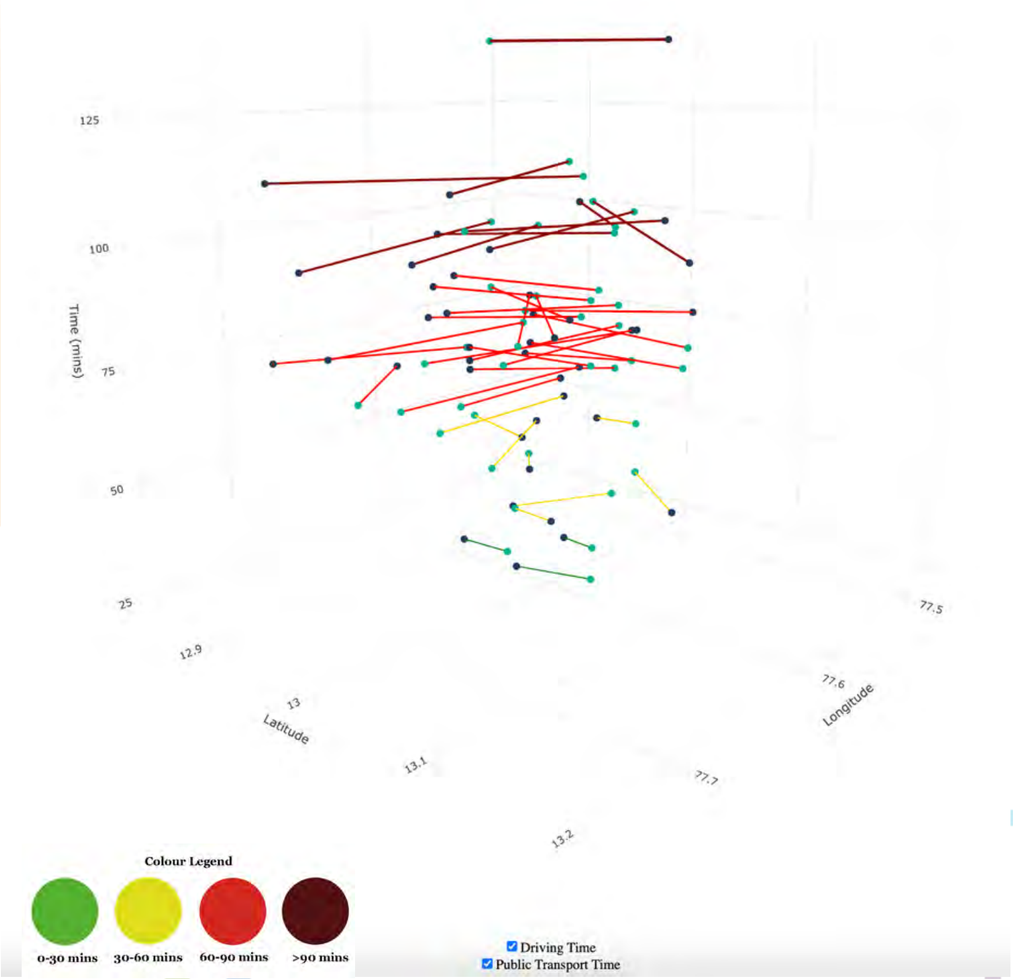


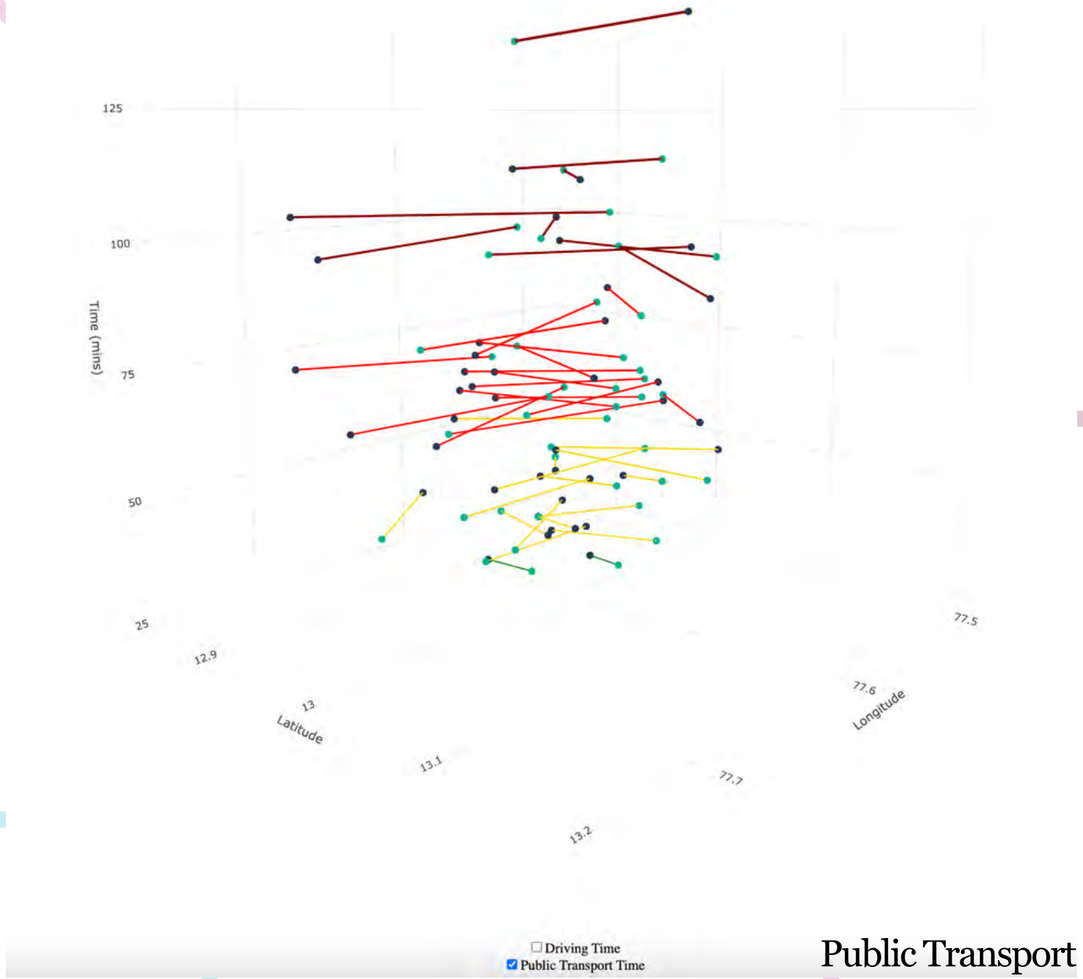




Public Transport

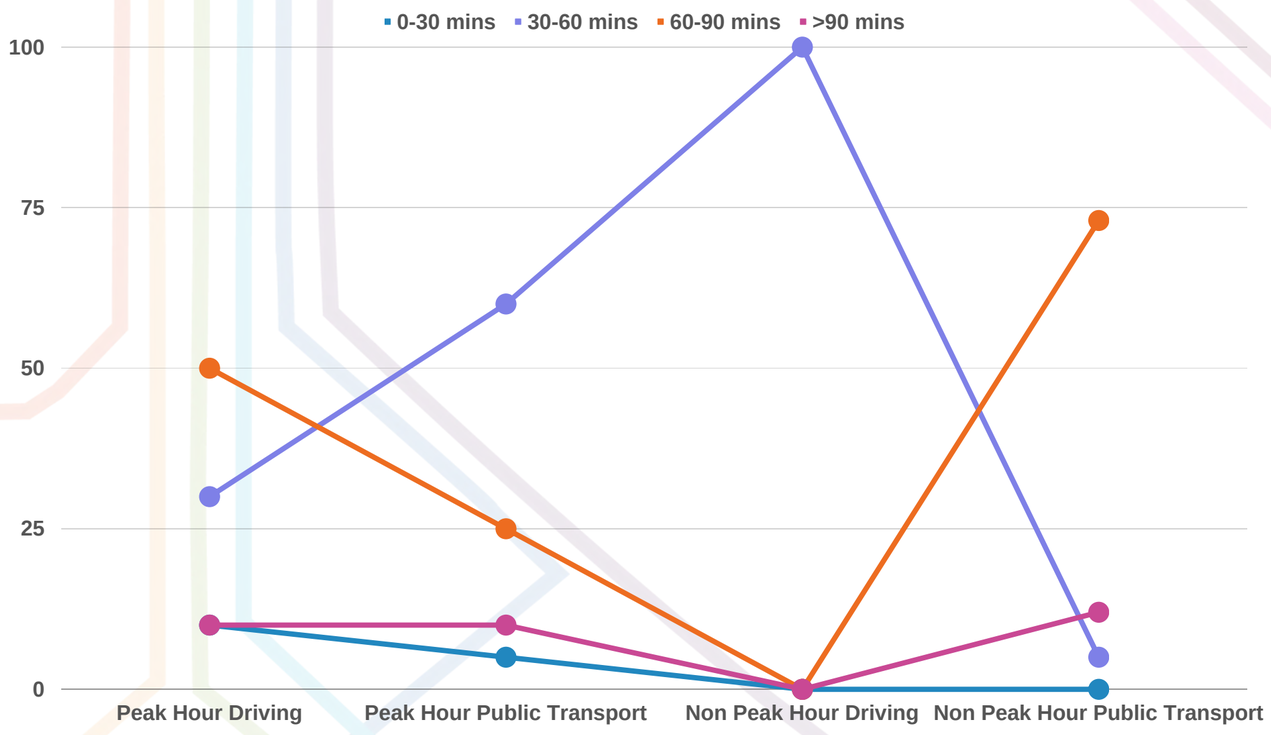
# Bengaluru - Peak hour

Driving

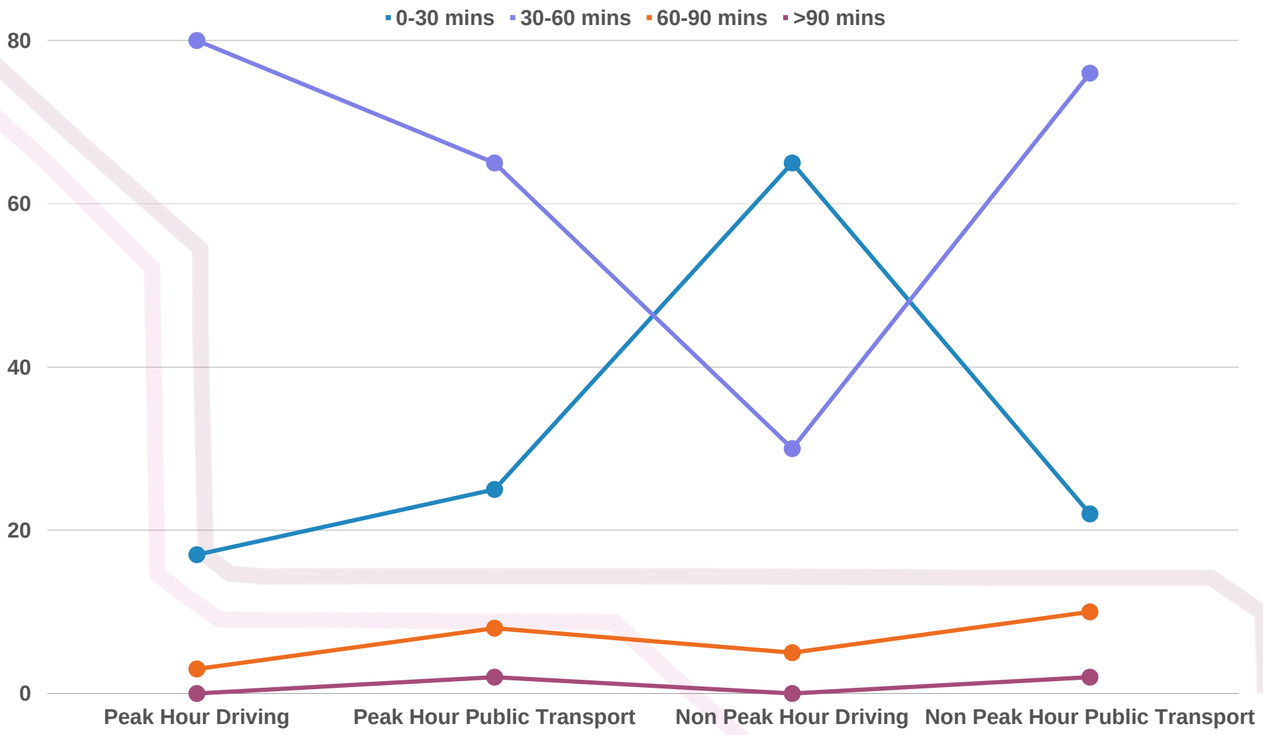



Public Transport




**Bengaluru**




**Amsterdam**

**Pattern:** With Bengaluru, the time spread mostly lies between 30–120 mins, while in Amsterdam the time trend lies between 30–60 mins. For the same distance range of 10-20 km, transit in BLR almost always takes double the time as AMS.

# Cartographic Visualisation of Patterns

The maps help visualise the distances and the impact a pattern analysis can help see when cartographically visualised and analysed.

→

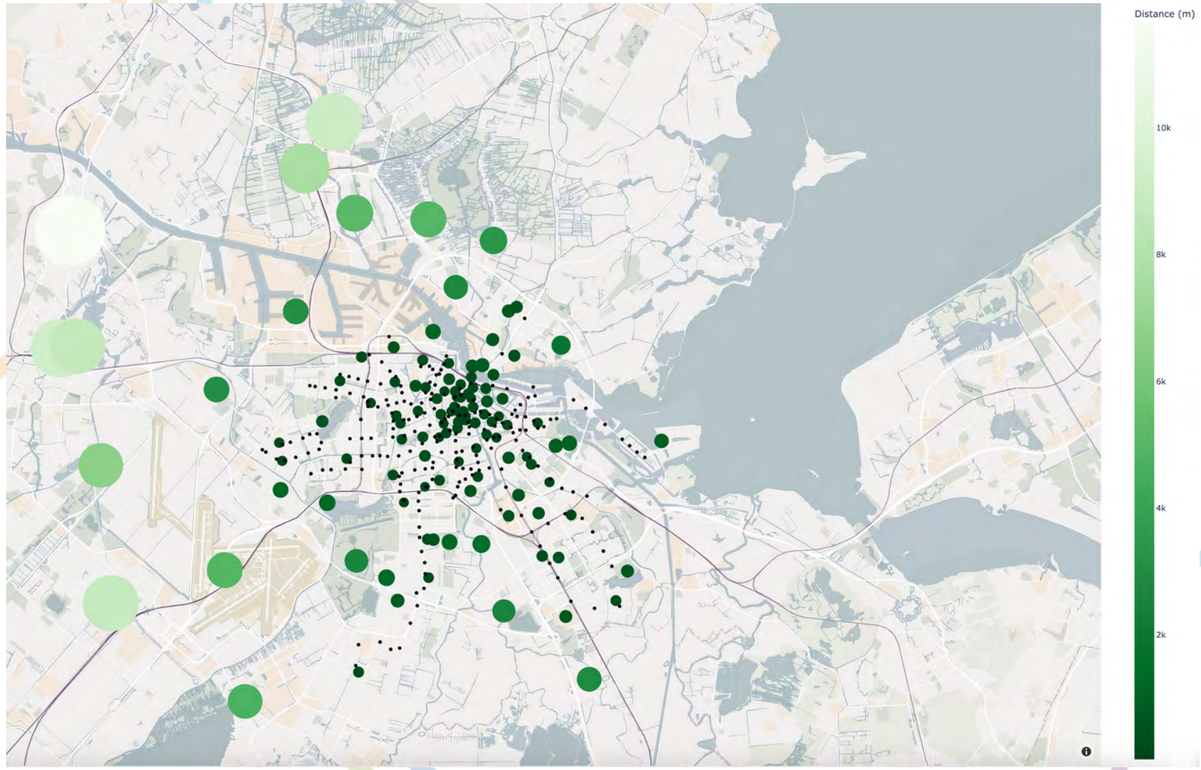
These maps illustrate each city's transit approach, and highlights the story of how these cities act in the urban environment.

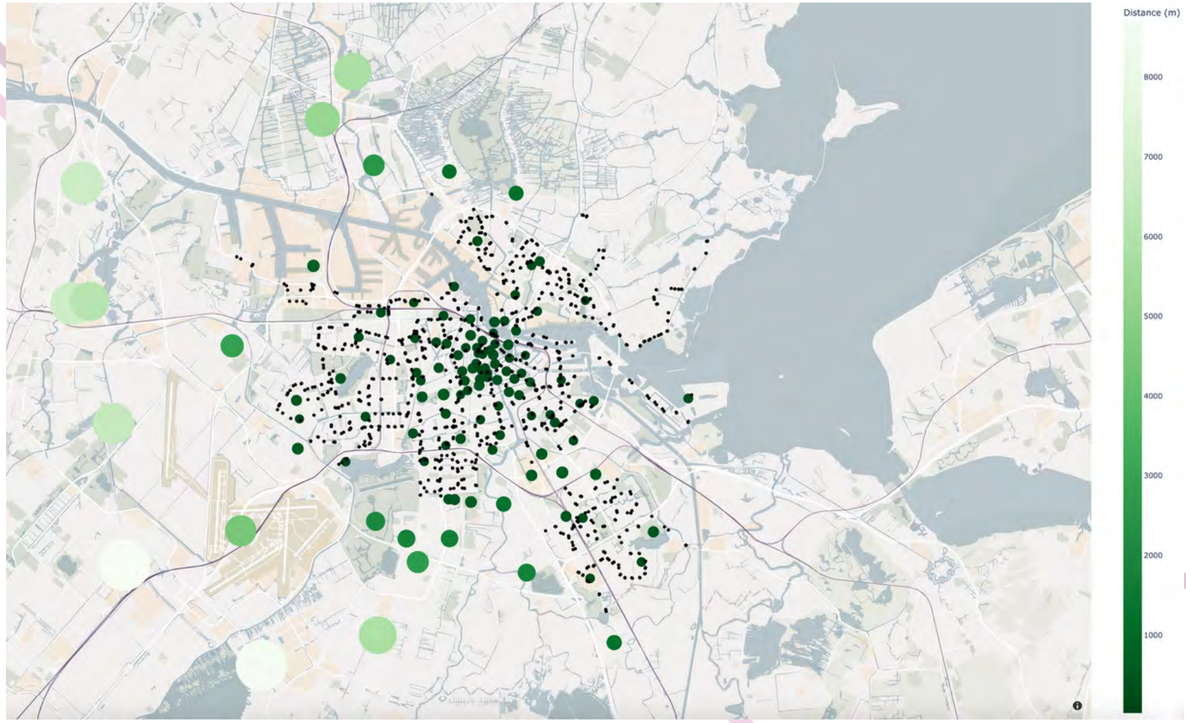
These cartographic data visualisations use the collected data points to reiterate the critical role maps can help in visualising a complex concept, which majorly deals with metrics.

# Amsterdam

The larger the size of the circle, the longer the distance to the nearest public transit point.

## Proximity to metro/tram stops




## Proximity to bus stops

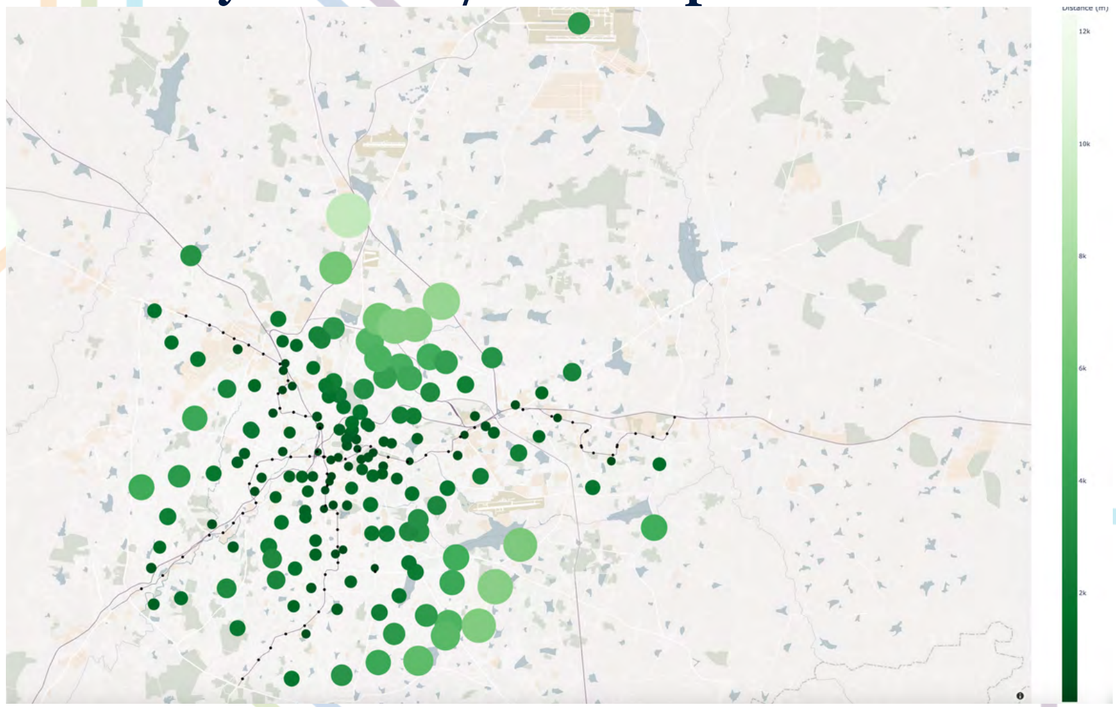
Demonstrates a clear pattern of closely integrating bus stops with train, tram, and ferry stops, fostering seamless intermodal transport within the city. Outliers are outside of GVB service area, but still is connected with suburban services.

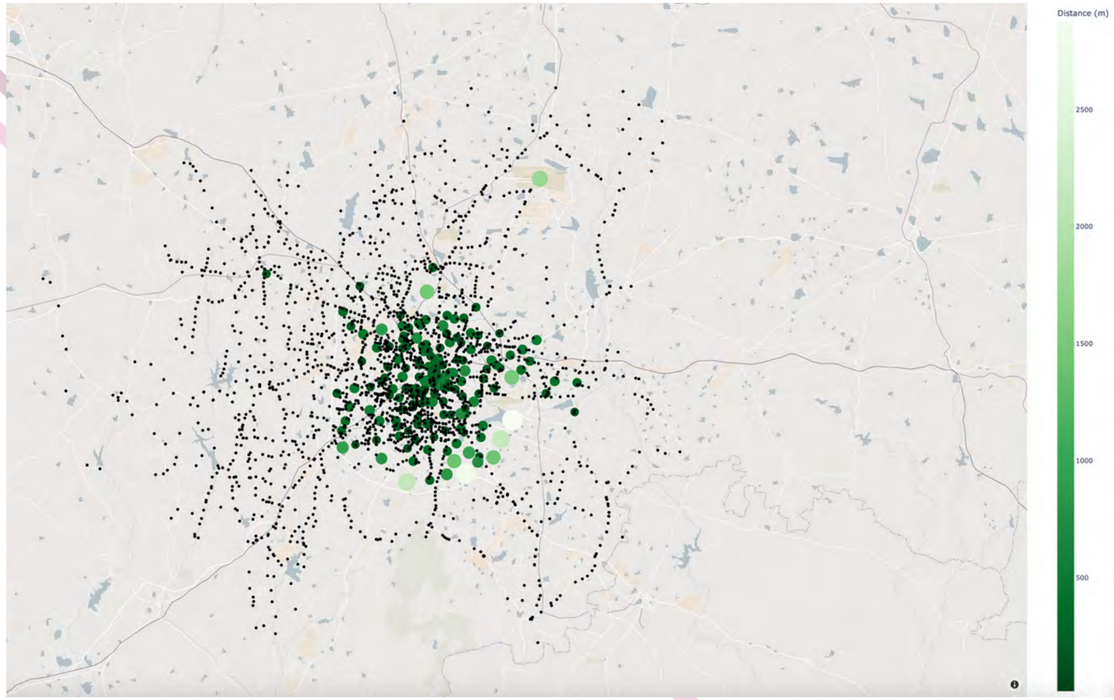
Colour and size, both indicate distance. Size is used as a factor to understand the impact.

# Bengaluru

The larger the size of the circle, the longer the distance to the nearest public transit point.

## Proximity to metro/tram stops



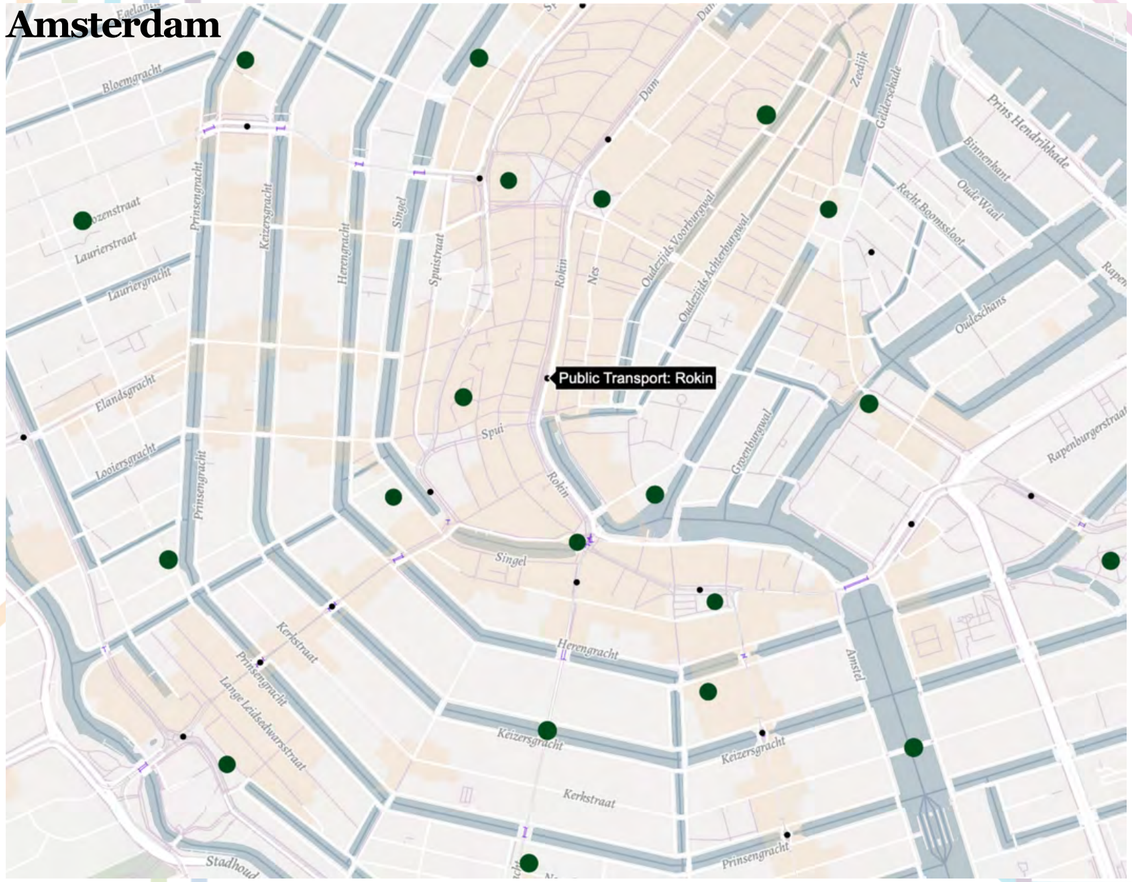



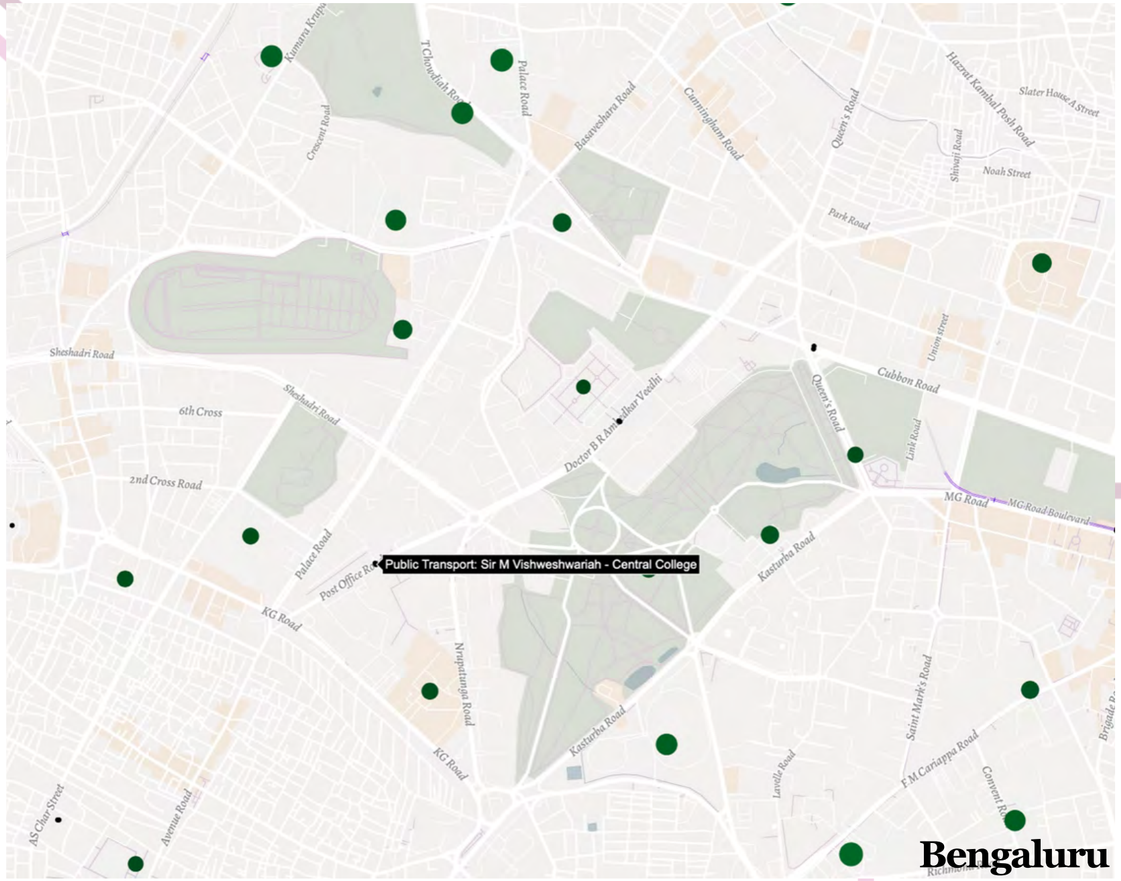

## Proximity to bus stops

A distinctive pattern emerges where bus stops have an extensive reach, but the same level of reach is not achieved by the metro stations. This discrepancy contributes to less efficient public transport routes within the city, as the inter-connectibility is not efficient enough for timely usage. Outliers here are still serviceable by BMTC/BMRCL but do not have connectivity yet.

Colour and size, both indicate distance. Size is used as a factor to understand the impact.

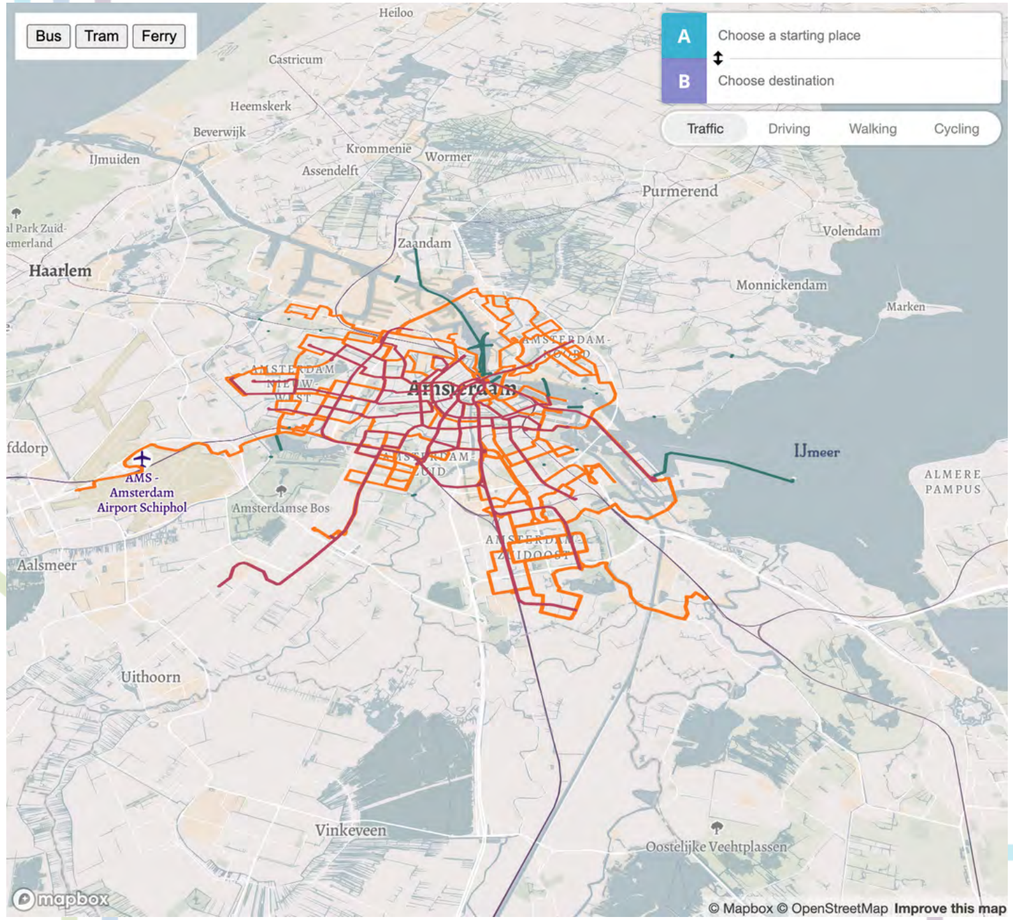
# Reachability

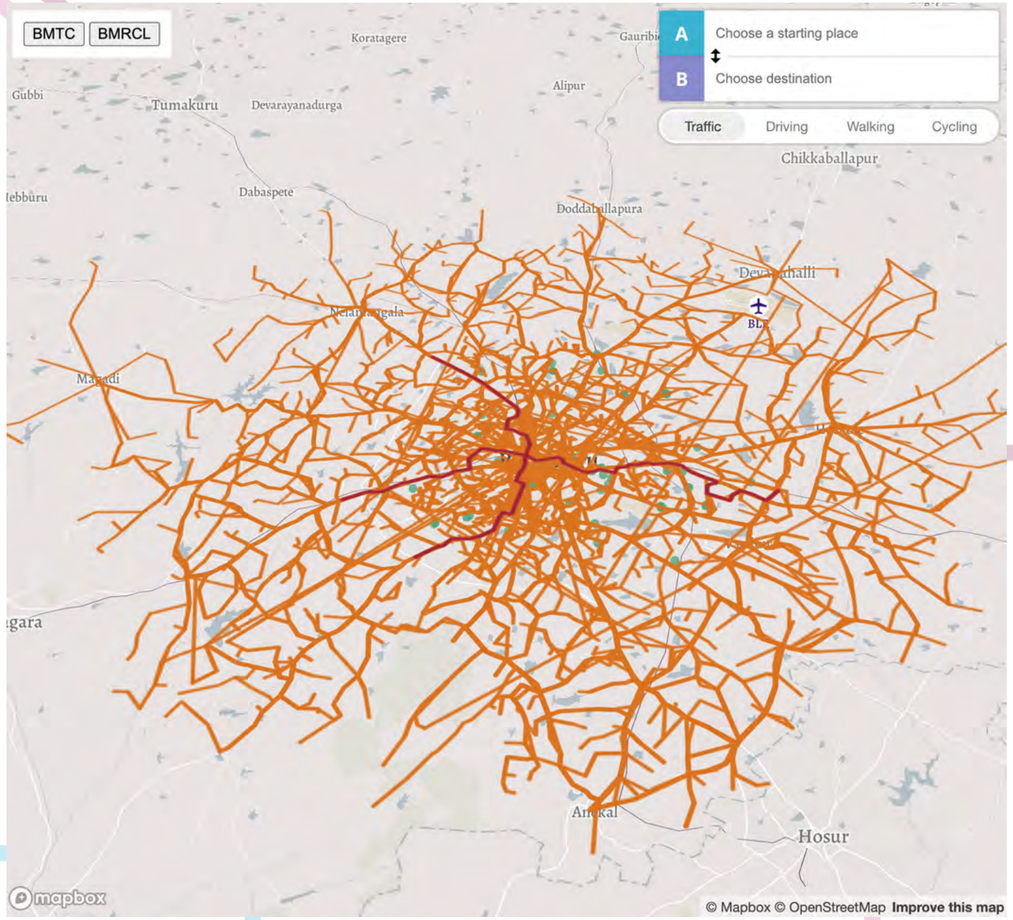


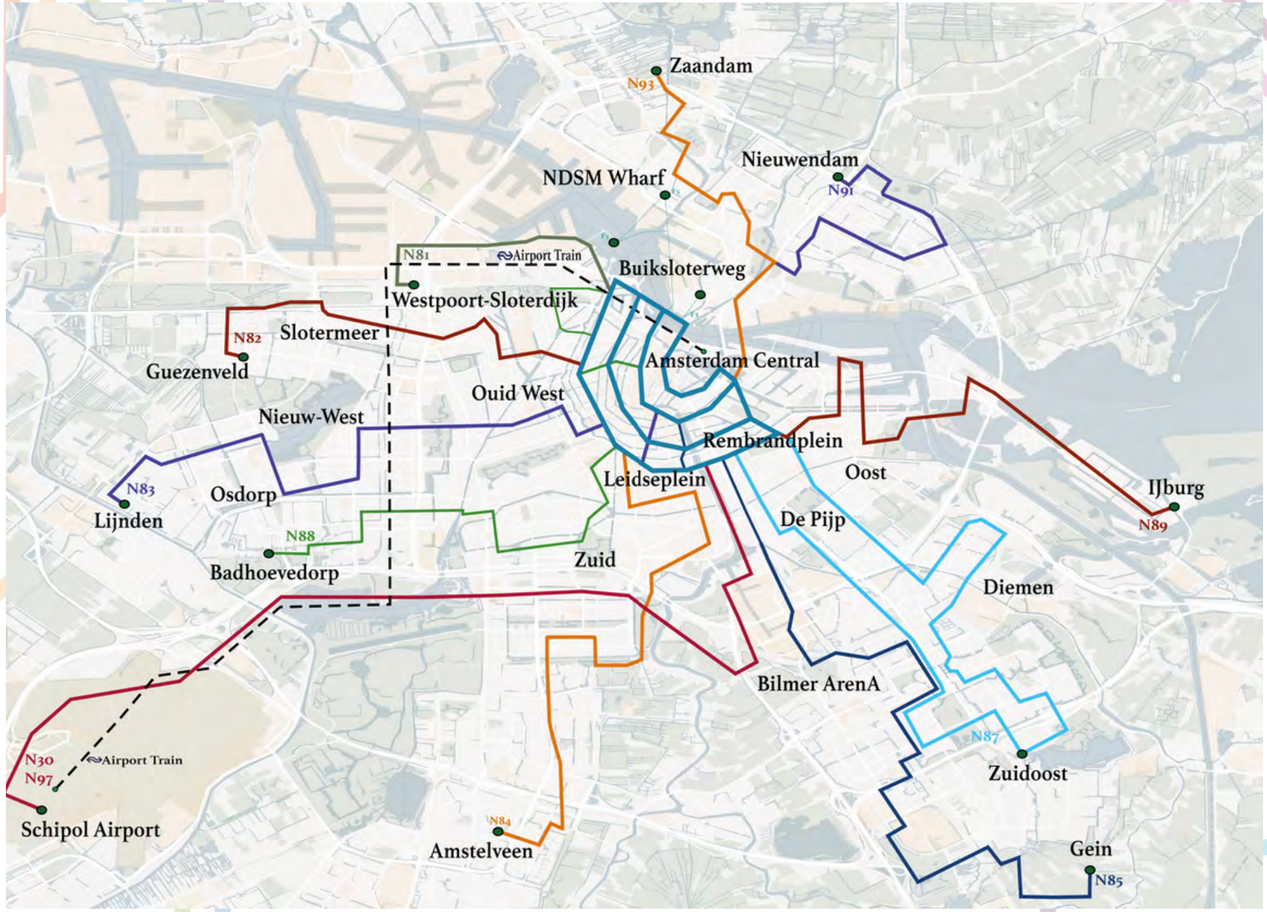

In Amsterdam's Rokin, transit points are closely spaced (50-250m) with uniform point sizes, while in Bengaluru's Central, points are more scattered (150-500m) with increasing point sizes, indicating longer distances. The orange zones represent commercial areas with high access, and the scatter pattern illustrates differences in reachability over important areas of similar radius, with dotted black points indicating the absence of public transport points near major points of interest (green).

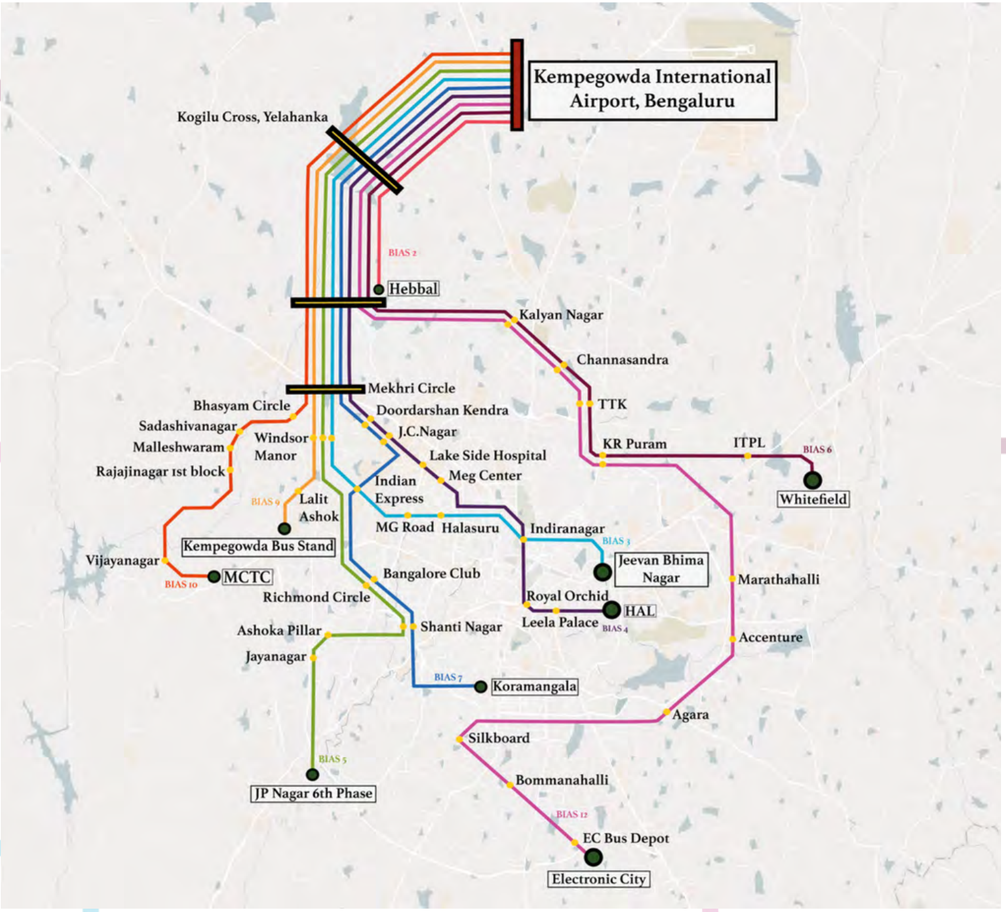
# Mobility Spread - Calm vs Chaotic



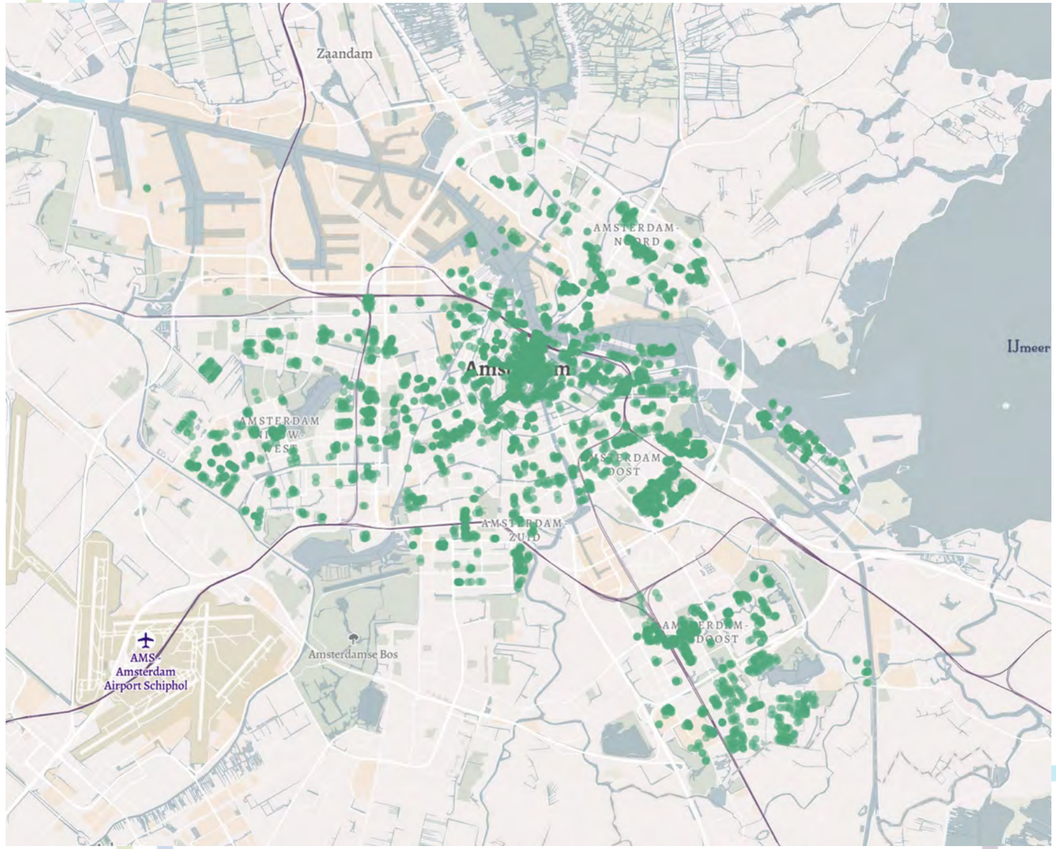



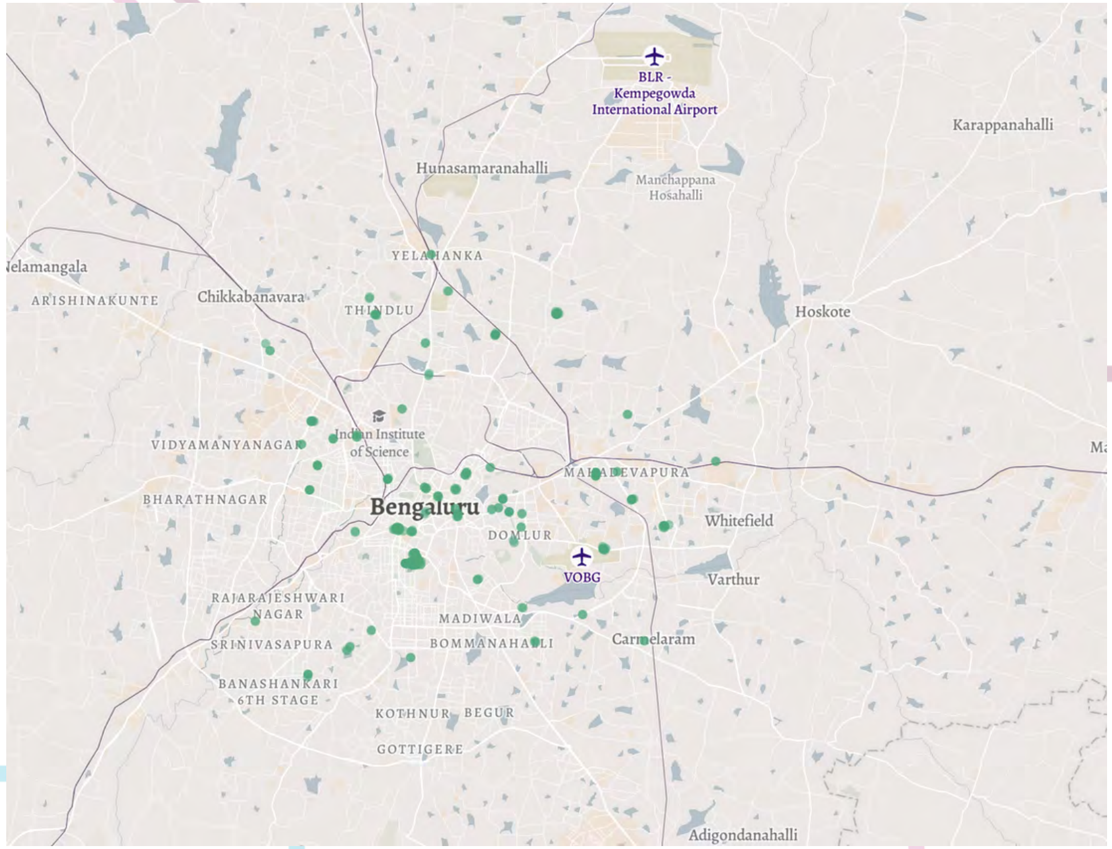
# Approach of Impactful Routing - Night Transit



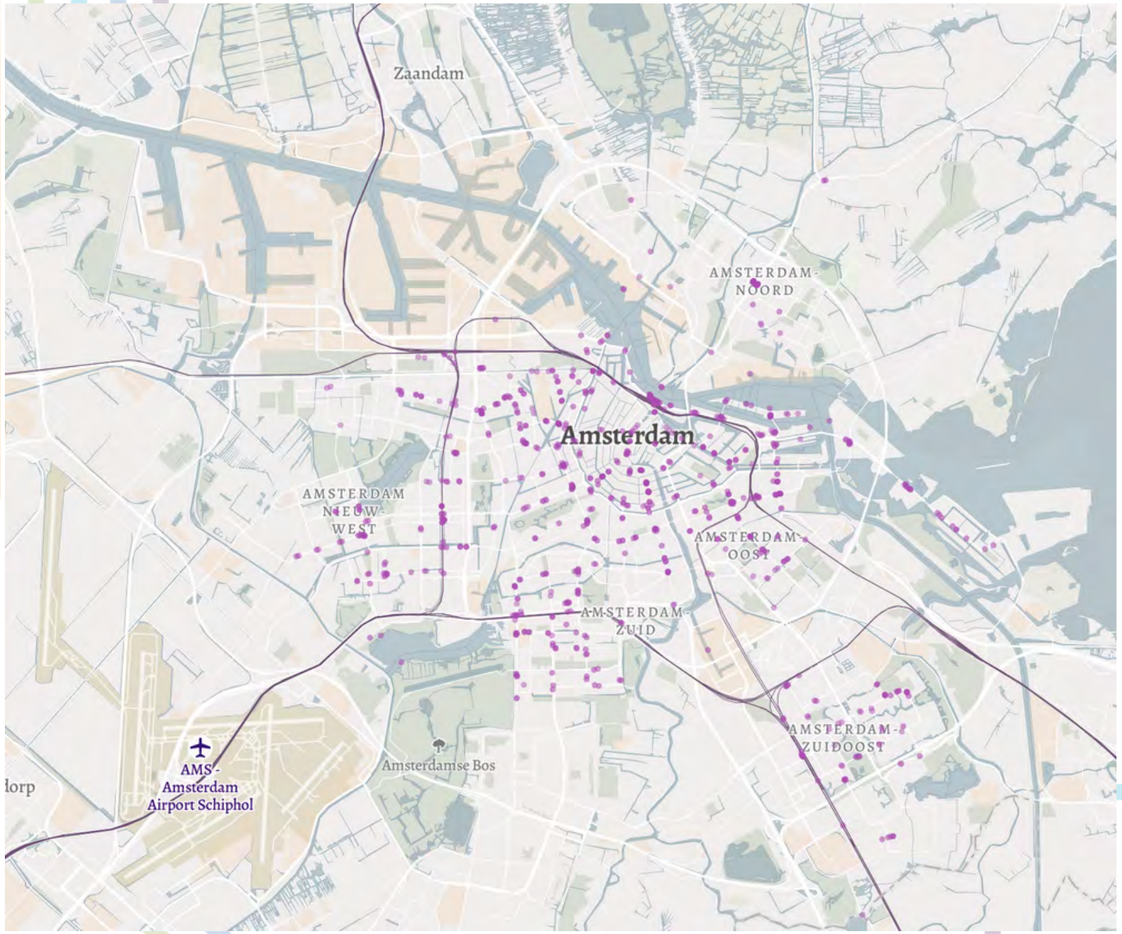



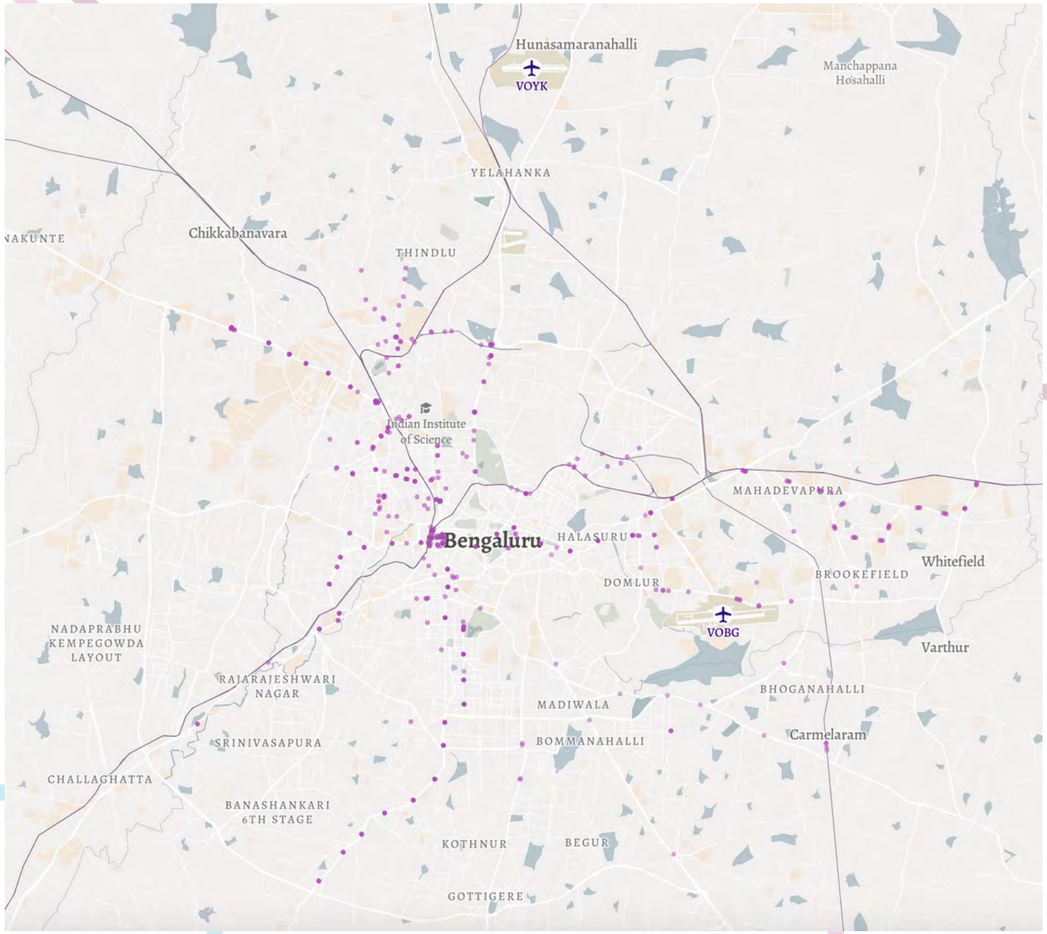
# Pedestrian Focus Patterns



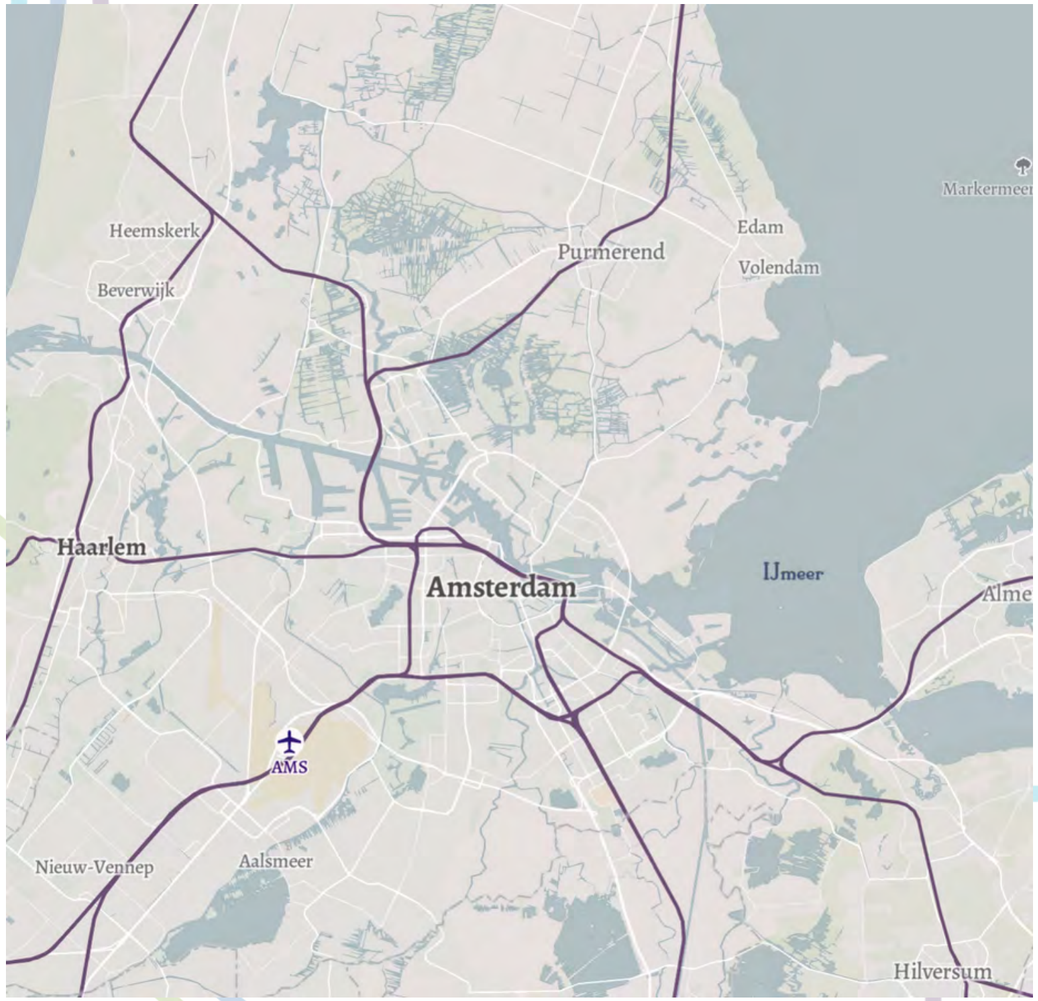



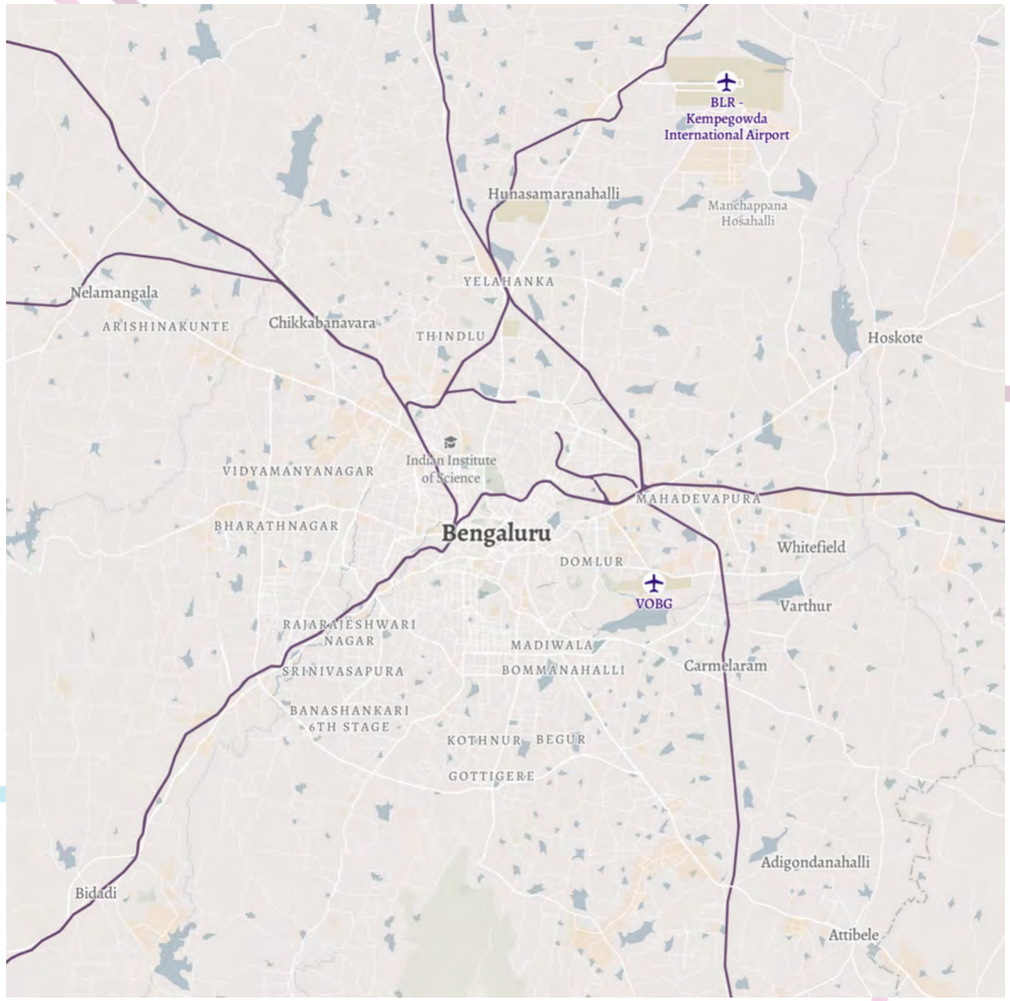
# Accessibility Patterns



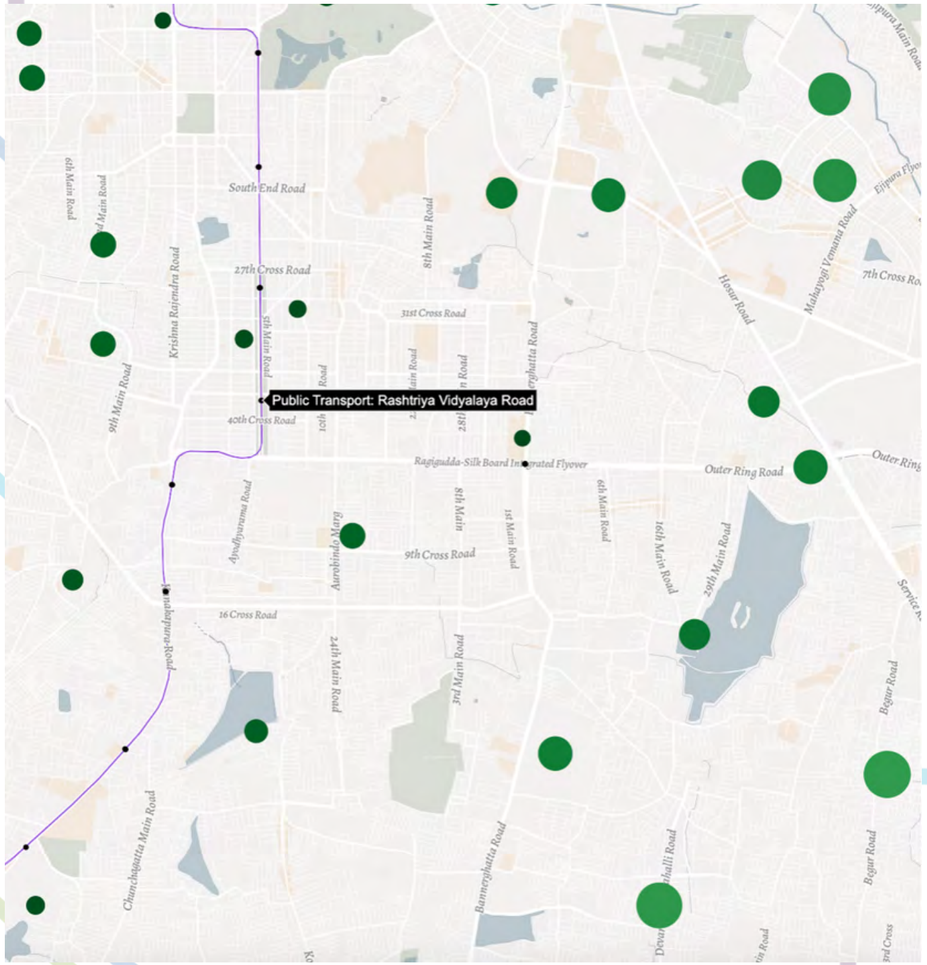



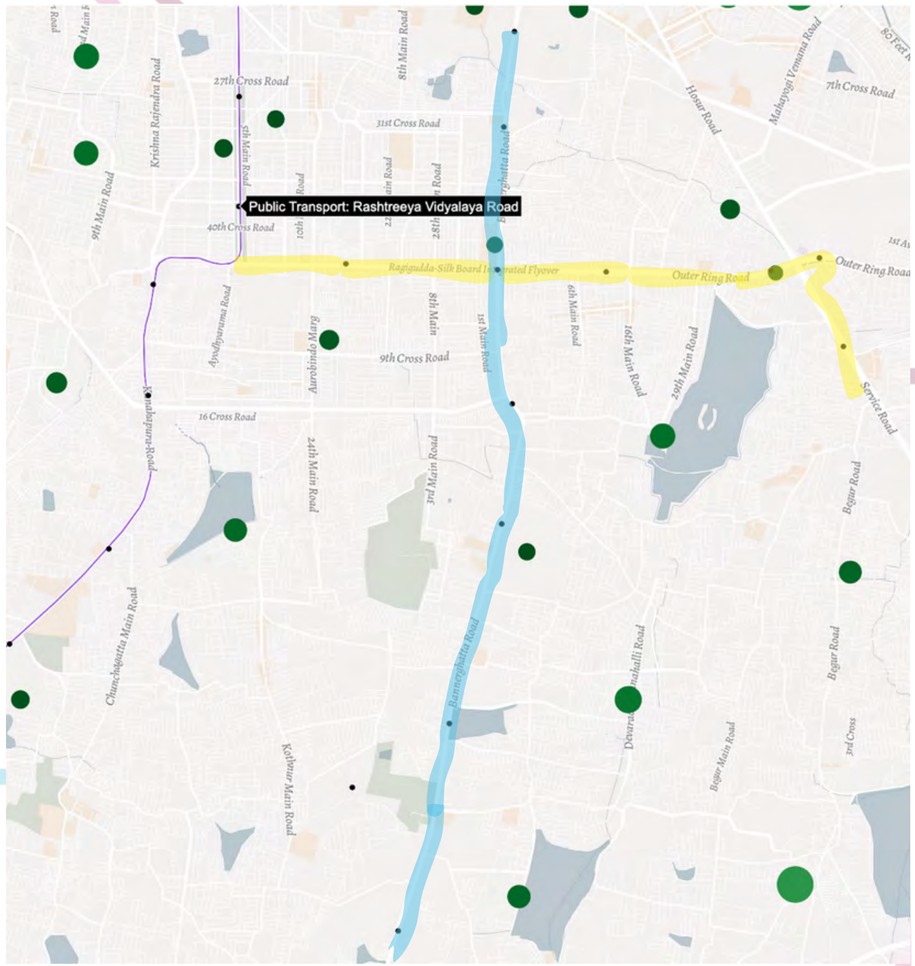
# Utilising Already Existing Infrastructure



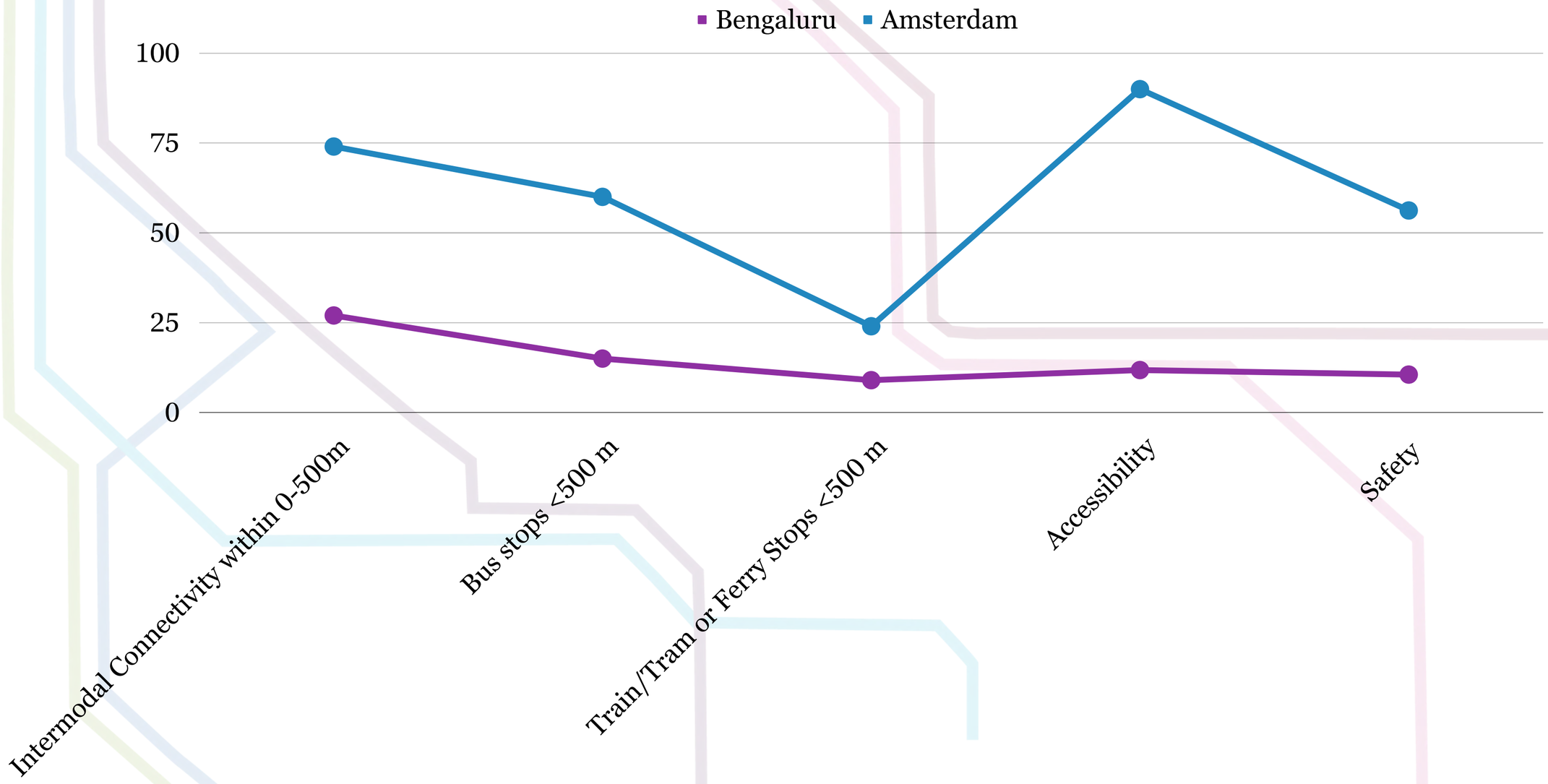
# The Impact of Good Transport Availability



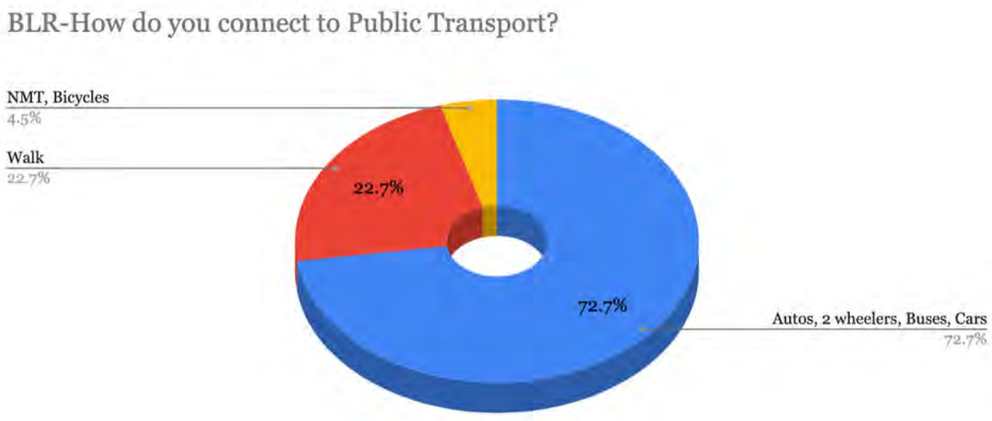
# Gaps' Highlights

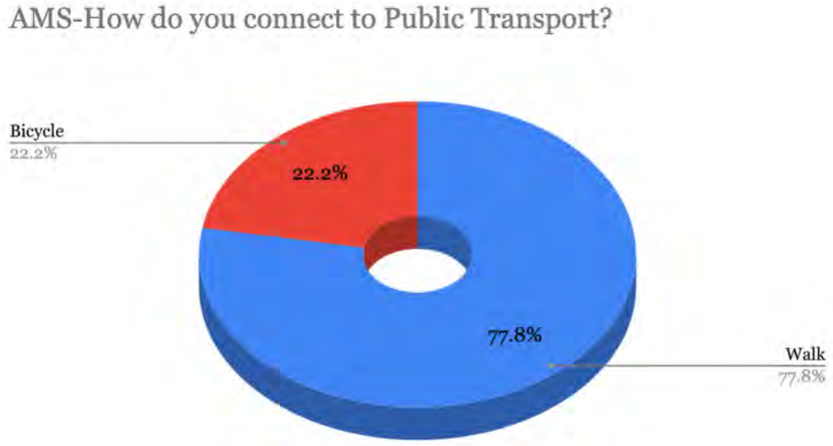
**How many elements are within easy access, walkable or appropriately accessible transit stops**

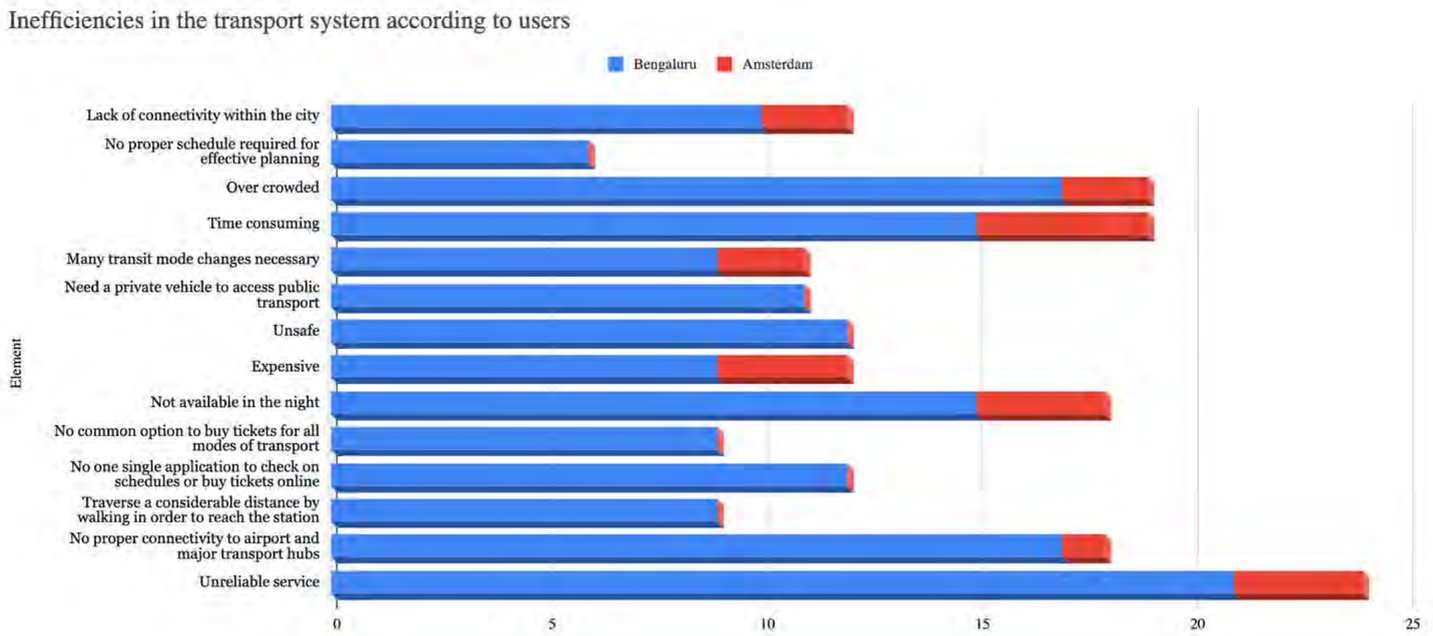


# User Perspectives

No of user responses: 51 (Blr: 27, AMS: 23)



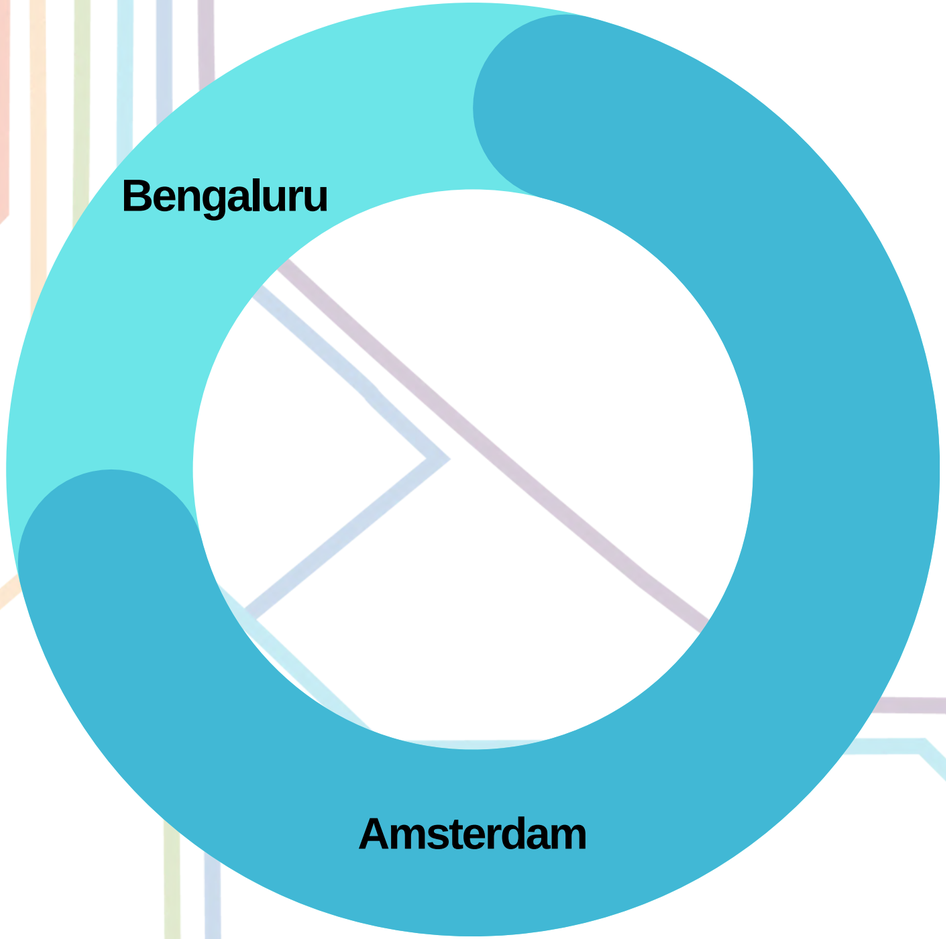

**User review: Average (both cities - users choosing these as the main elements of a gap)**

- Traffic congestion (74%)
- Unreliable public transport (67.7%)
- Lack of proper transport infrastructure (54%)
- Safety concerns while using public transport (58%)

# Current State according to Mobility Indicators

| Element | Amsterdam | Bengaluru |
|---|---|---|
| Availability of night transport | Yes | No |
| One single ticket for all modes of public transport | Yes | No |
| Affordable means of public transport | Yes | Yes |
| Availability of open and clear schedules at transit stops | Yes | Only at metro stations |
| Availability of smart travel options | Yes | Only for Namma Metro |
| Good frequency of public transport | Yes | Yes |
| Great frequency of public transport at night | Every half hour | Every hour only airport routes |
| Optimum routes | Yes | Yes |
| Good accessibility | Yes | No |
| Crowded | During Peak Hours | Overcrowded during Peak Hours |
| Enough number of vehicles in the fleet for the current needs of the population | Yes | No |
| Safety | Yes | Relatively unsafe at night times |

# Learnings



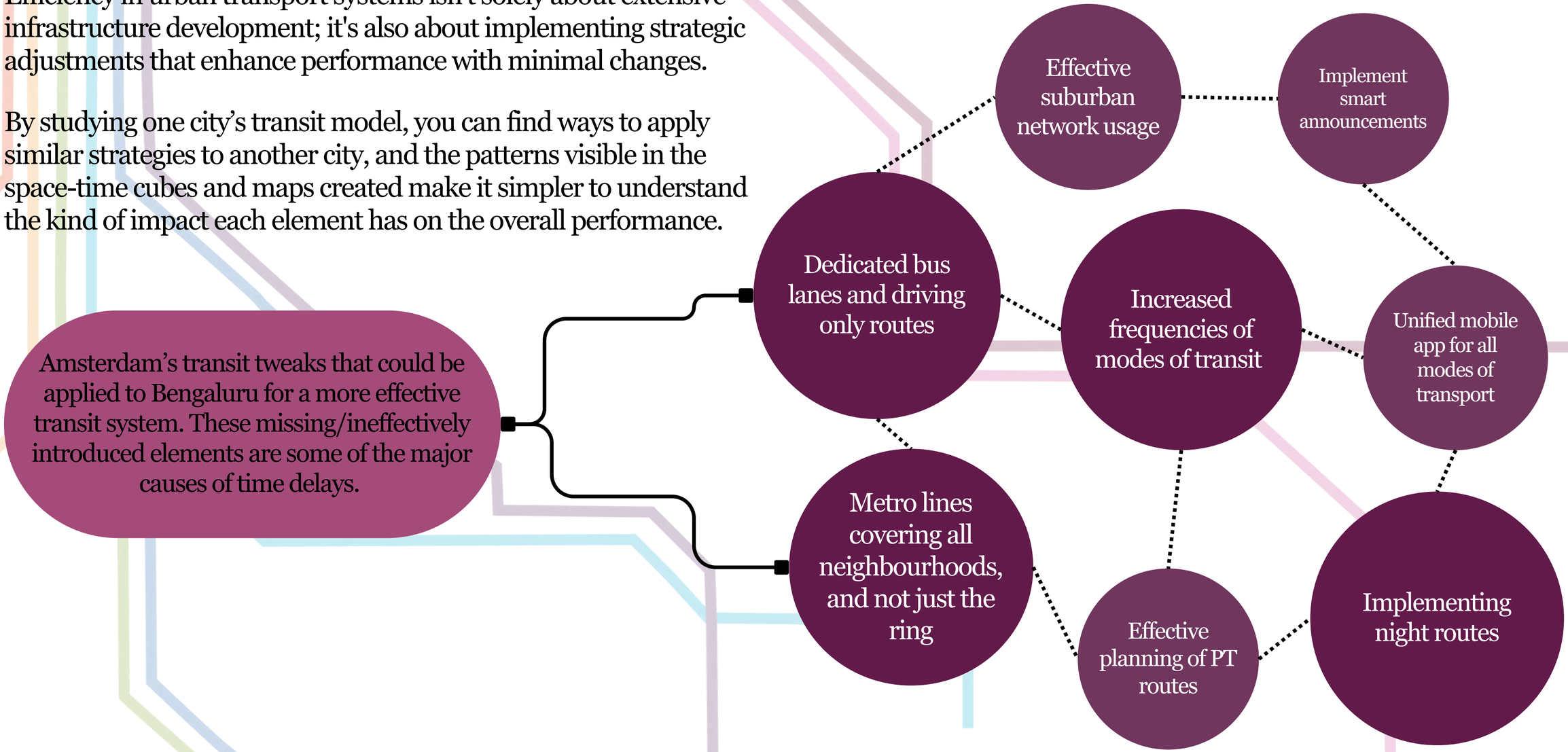

Amsterdam outperforms Bangalore in various aspects of an effective transport model, with a performance rate of 75%, while Bengaluru lags behind, exhibiting inefficiencies and deficiencies in the same aspects due to ineffective enforcement of the elements.

This ineffective enforcement impact can be very easily understood using the cartographic representation of the elements that are considered as gaps.

# Results

Efficiency in urban transport systems isn't solely about extensive infrastructure development; it's also about implementing strategic adjustments that enhance performance with minimal changes.

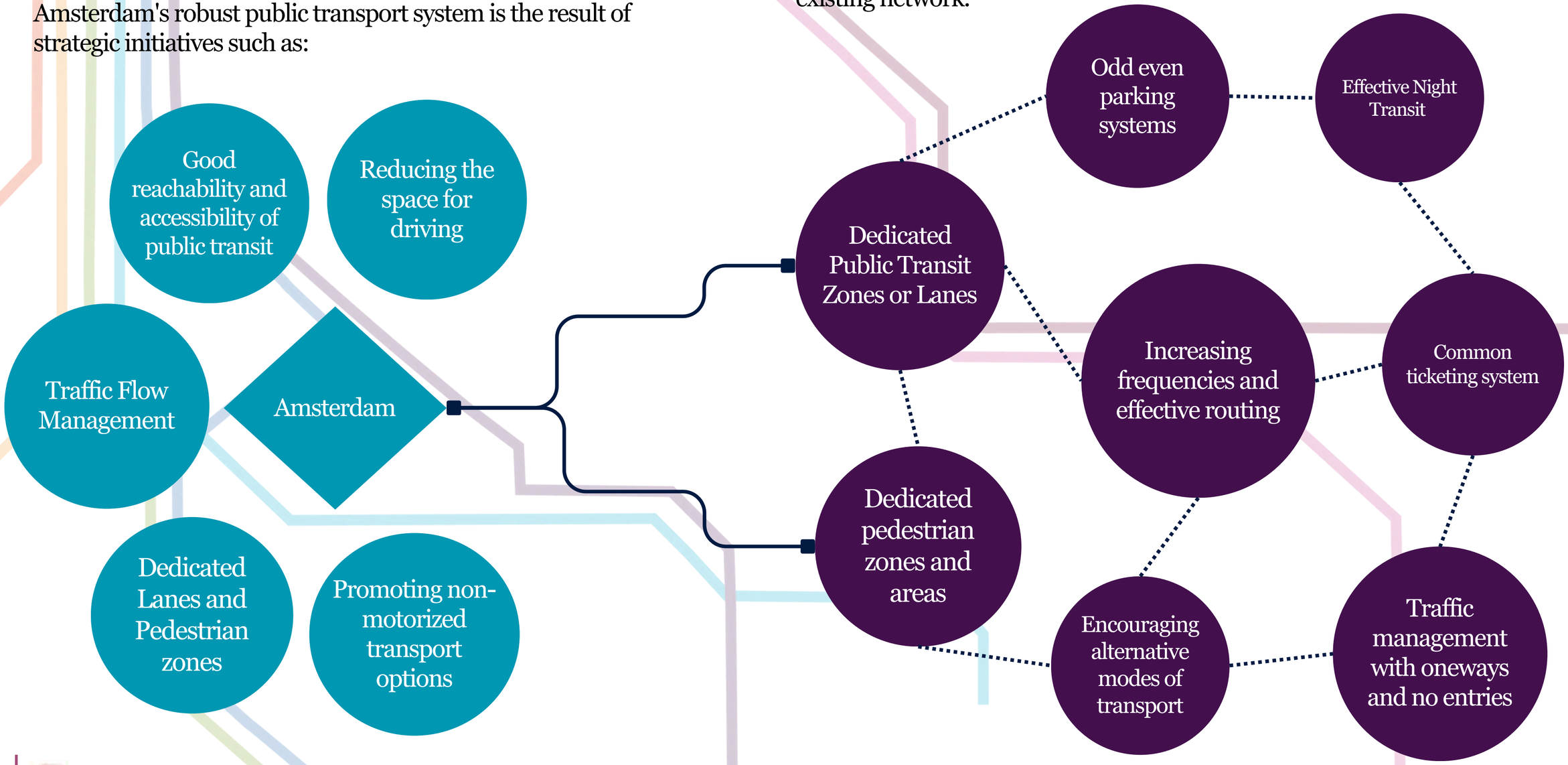
By studying one city's transit model, you can find ways to apply similar strategies to another city, and the patterns visible in the space-time cubes and maps created make it simpler to understand the kind of impact each element has on the overall performance.



# Discussion

The same could be applied to other cities, without having to create new and expensive infrastructure to improvise the existing network.

Amsterdam's robust public transport system is the result of strategic initiatives such as:



# Conclusion

Transport is a complex concept to visualise, however, maps can strategically play an important role to simplify it and highlight the impact.

The spread of transport, when visualised, show interesting patterns that this thesis has tried to highlight in all the maps and the space-time cubes created.

Analyzing gaps and patterns helps identify areas where cities like Bengaluru can benefit from adopting transit models or patterns similar to those in cities like Amsterdam.

# Challenges

### Limited Data

Lack of proper mapping of data and the availability of datasets, and the processing requirements needed for such large datasets are a major hinder to the cartographic visualisations of transport problems.

### Complexity of the codes

Working with different sets of codes and challenges in displaying images in the space-time cube were encountered. Multiple deprecated modules with Three.js added another level of complexity to the code building and analysis.

### Transport is a very wide concept

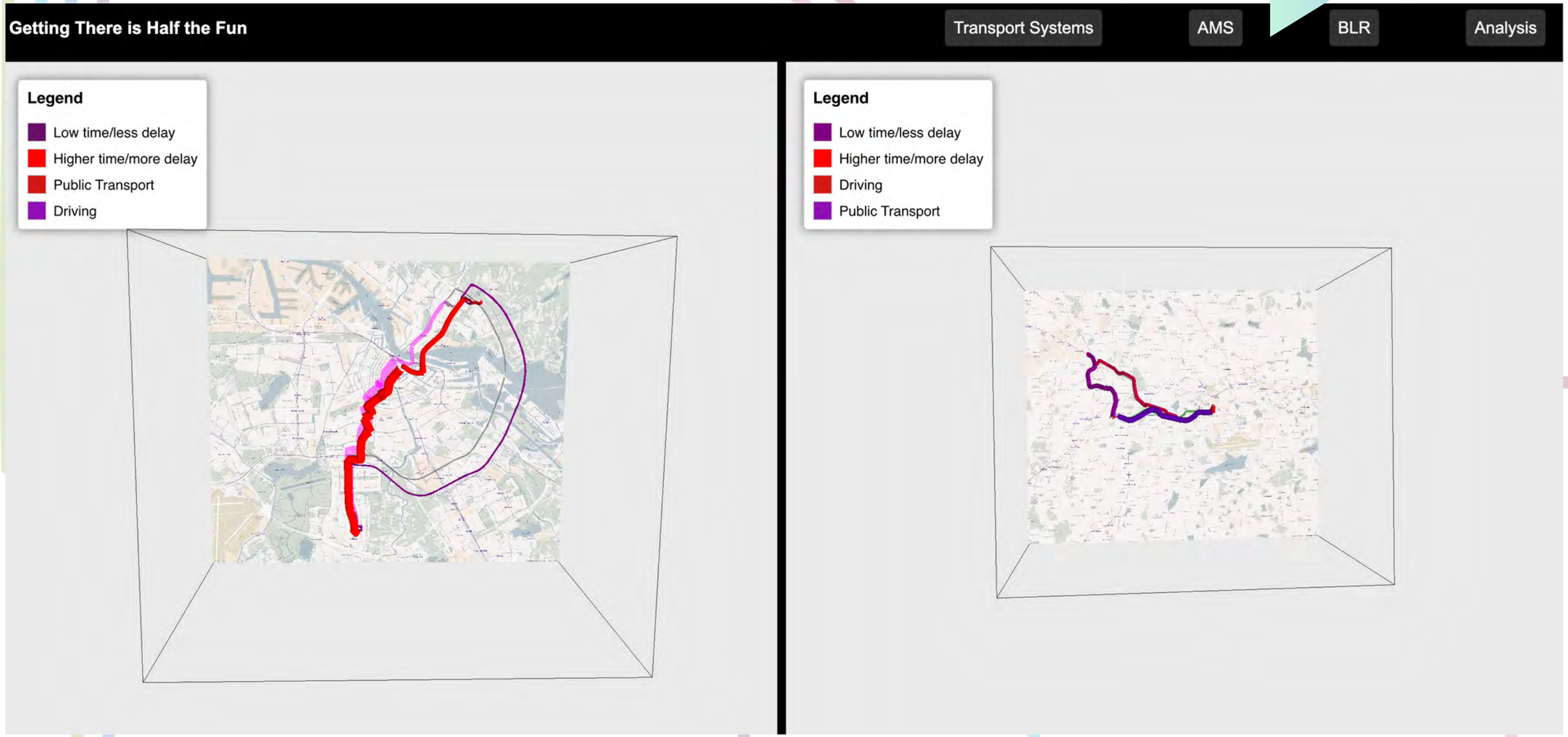
Within the given timeframe of six months, conducting a comprehensive comparison of every aspect of the mobility index was not possible. Therefore, the focus was limited to cartographically visualising and analysing 50 routes and 100 points across the cities to identify the existing transportation networks and the possible gaps.

### Cartographically visualising abstract patterns

Visualising abstract pattern concepts like the spread of the gaps, the time or connectivity metrics in the cartographic form was a challenge. To understand which visualisation works, and is compatible with the data but also easy enough to understand was harder to pinpoint and visualise. Heatmaps were one of the top choices but proved to be harder to visualise the distances seen in the analysis correctly, hence scatter plots were used for giving the same understanding but on an easier level.

# Further Work

The Python Analysis Interactivity Maps will also be updated on GitHub Pages, in AMS and BLR Tabs




The interactive map for the space-time cubes, and the interactive routes viz are now hosted on GitHub and future similar studies will be conducted for other cities, prioritising developing cities in comparison with developed ones.

# Thank you!
# Off to be stuck in some traffic jam!

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