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Comparative Analysis of Cycling Route Choice by Bikes and E-bikes: The Case Study of Tartu, Estonia

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NECTAR Conference 2026

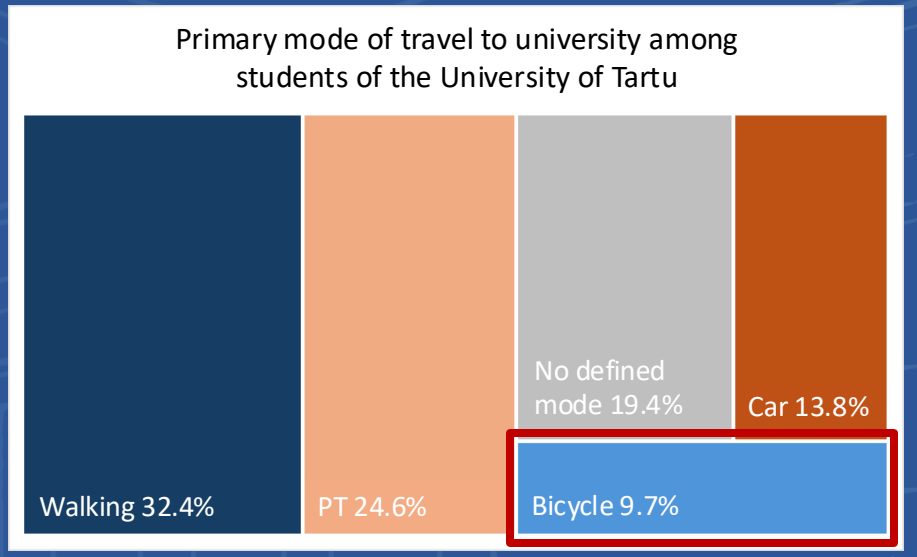
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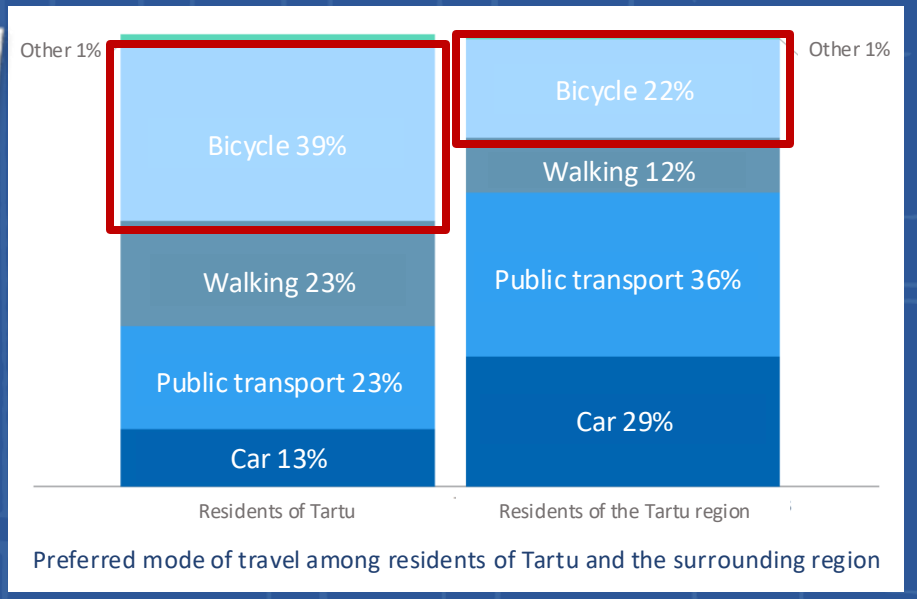
Understanding urban cycling

- Urban cycling has a key role in decarbonising urban mobility.
- E-bikes emit five times less emissions per km than cars.
- E-bikes enable longer trips with less physical effort.
- Evidence suggests e-bike users' travel behaviour differs from regular bicycle users.
- E-bike sales are quickly increasing.
- Strong inclination to cycle in society.


Electric bike sales around the world pass key milestones



Source: University of Tartu Mobility Survey



Source: Tartu Energy and Climate Strategy 2030

How can we increase urban cycling?

- Understanding travel behaviour of cyclists enables targeted interventions.
- Previous studies have shown that cyclists frequently detour from the shortest route.
- Segregated cycleways are important for cycling uptake, but what else?

What specific route features do cyclists prefer/avoid?

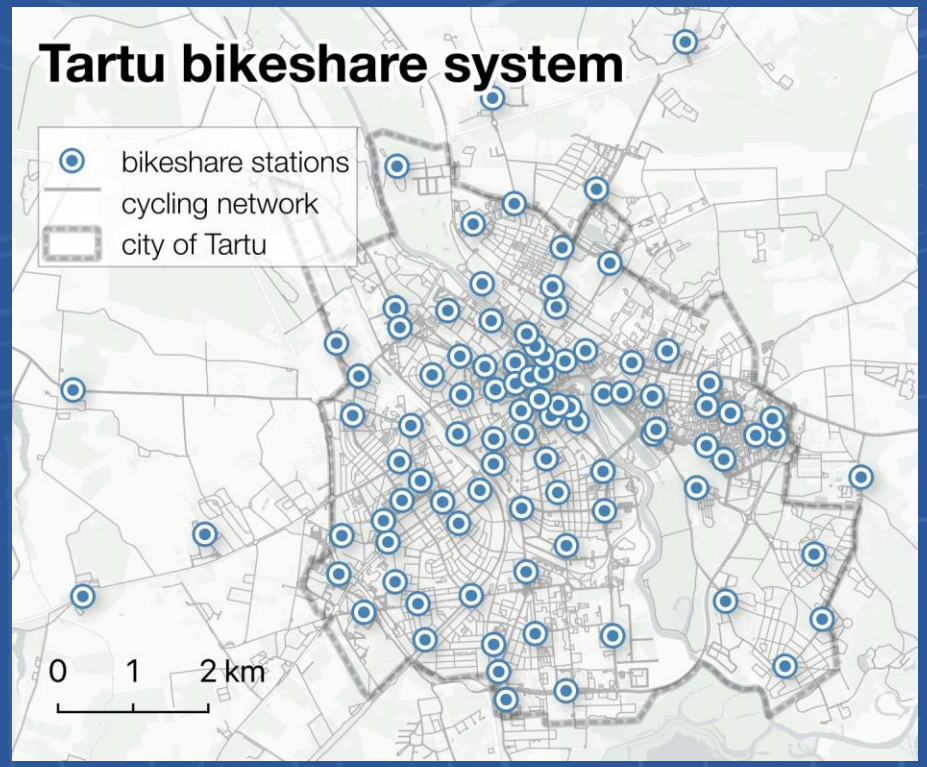
What are the differences in route choice preferences between e-bike and regular bike users?

- Cycling is usually treated as a uniform mode of travel in transport models.
- Few studies have analysed the travel behaviour of e-bike users.

Bikeshare system in Tartu

- Tartu is the second-largest city in Estonia
- Tartu bikeshare system
  - launched in 2019
  - 102 stations
  - 750 bicycles (500 e-bikes)
  - 250 regular bicycles remain in use all year
  - Dock-based system
- One of the top 10 most utilised bike-share systems worldwide (Saidla et al., 2024).
  - Around six trips per bicycle per day in its first year.
  - 20.4 trips per day per 1000 people.
  - Relative to population size, Tartu is the smallest city among the top 20 top-performing bikeshare cities.





Top 5 cities with most bikeshare trips per 1000 inhabitants from 148 EU cities

City	Trips/1000 inhabitants/day
Paris	36.9
Antwerp	36.1
Ljubljana	26.0
Tartu	20.4
Toulouse	19.8

Source: Cycling Industries Europe (2024)

Cycling dataset

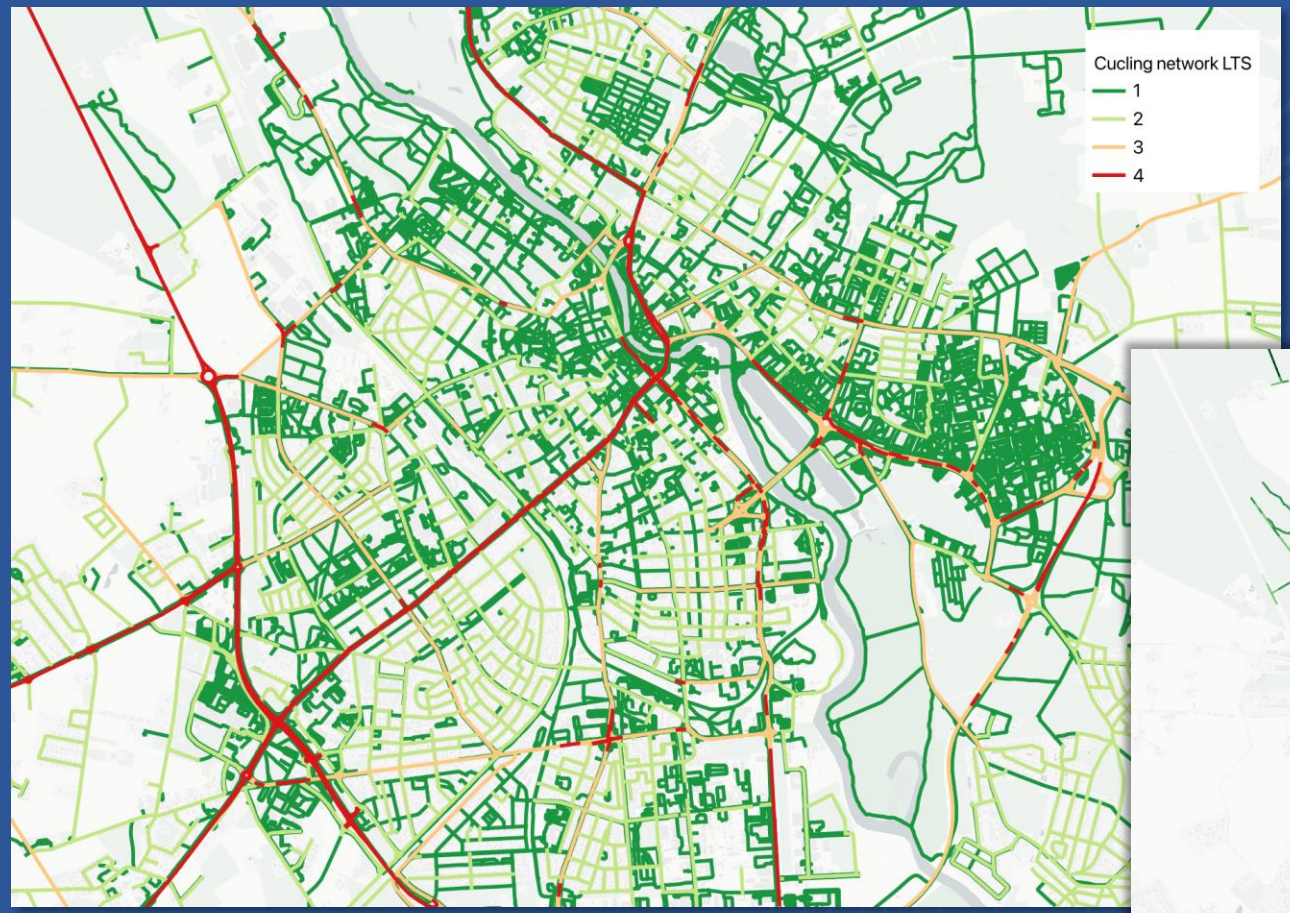
- 597,877 trips by 12,116 users in 2024
  - Over five million trips since 2019
- Pseudonymised dataset
- Start station, end station
- Bicycle type
- Membership type
- Date of birth
- Gender
- Location measured every 5 seconds
- 5-15m GPS accuracy



Route choice modelling workflow

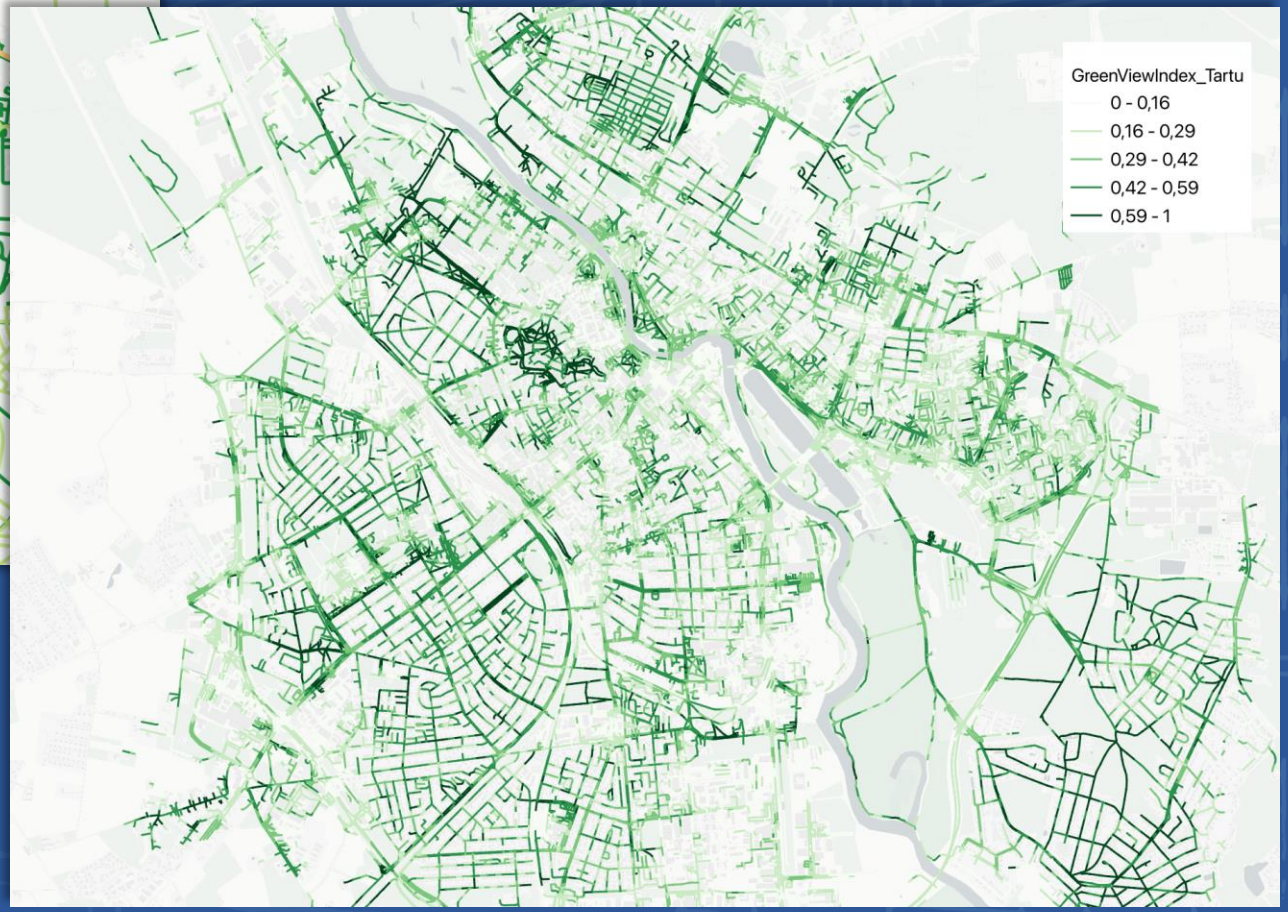
Performed on a subset

Data cleaning	Routable cycling network construction	Cycling route mapmatching	Route choice set generation	Enrichment with attributes	Model estimation
GPS data Trip overview data Station data OSM data	Cycling infrastructure classification Topology corrections Graph construction for routing	Graphhopper based hidden Markow model with custom cycling profile	Generation of alternative non-chosen routes Breadth-first search on link elimination	Distance Cycling infrastructure provision Road surface Level of Traffic Stress (LTS) Greenery Max speed …	Path-size logit model based on discrete choice modelling framework

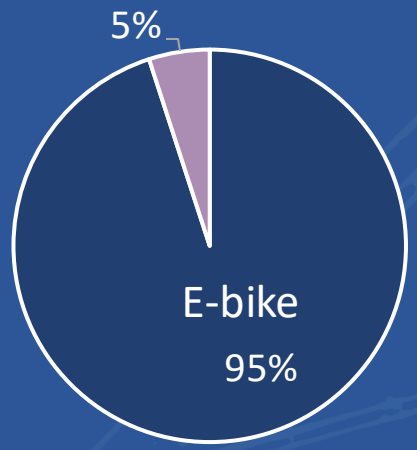


LTS – Level of Traffic Stress

Greenview index

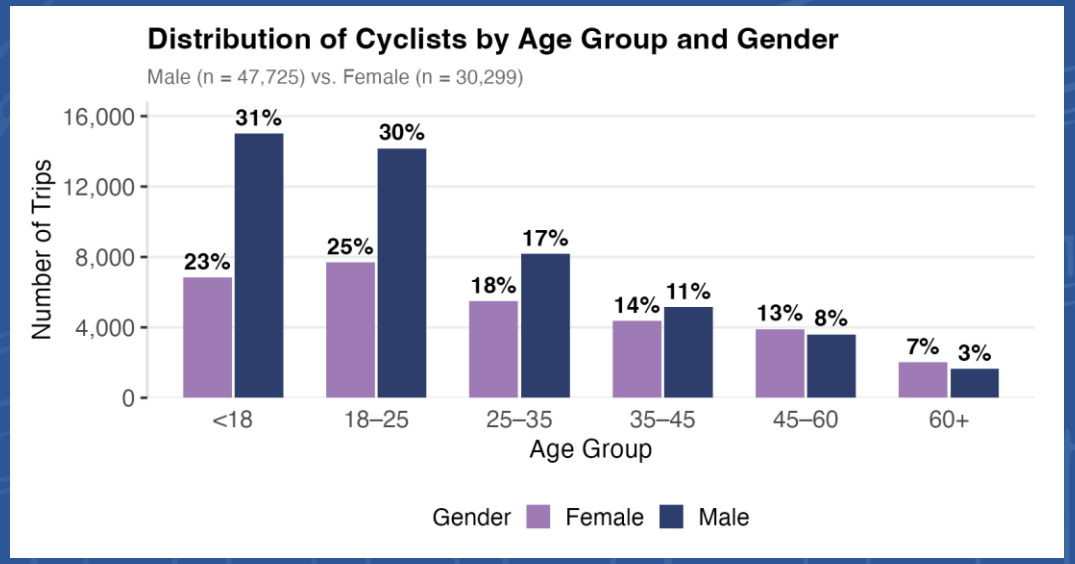


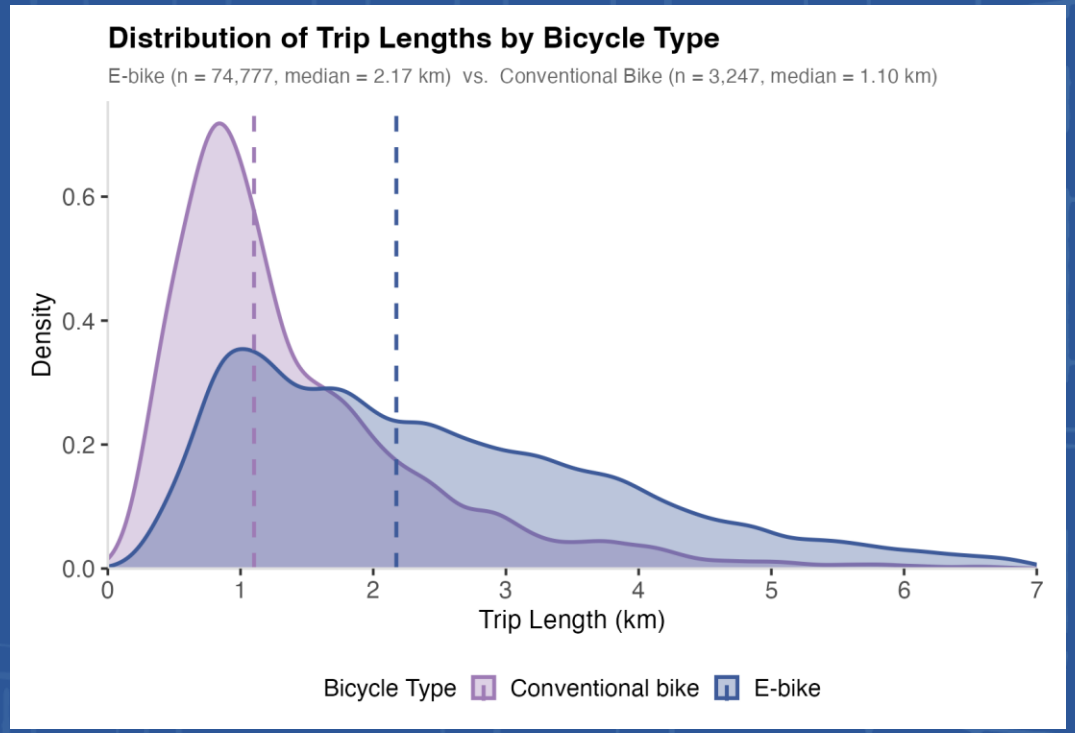
Results



- Sample of 70,521 cycling trips
- Only trips within the city of Tartu
- Trips with different start and end stations

- E-bikes are heavily preferred by users
- Longer trips are undertaken with e-bikes



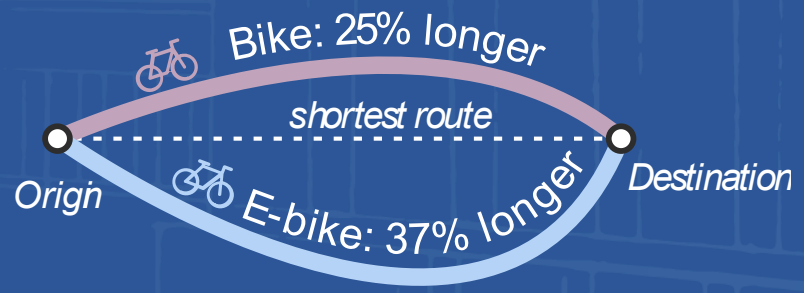


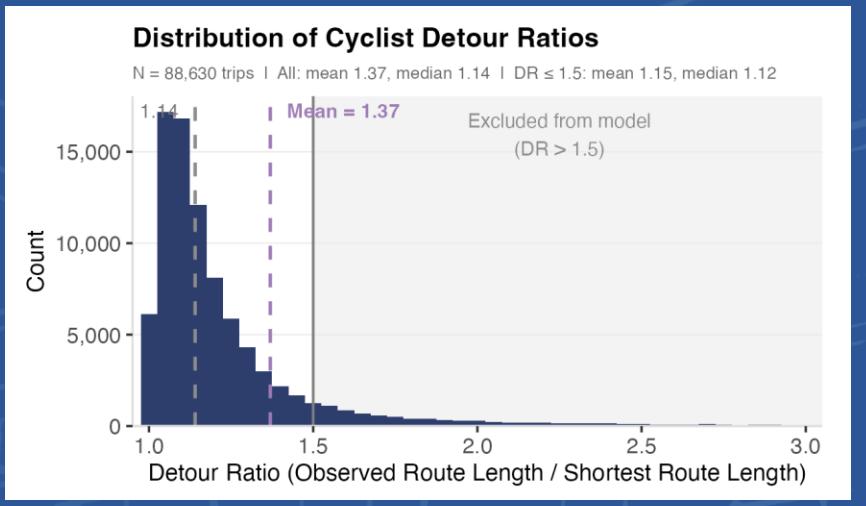
Trip Statistics by Bike Type

Bicycle type	Count	Percentage	Avg trip length (m)	Median trip length (m)
E-bike	74,777	95.8%	2,581	2,174
Conventional bike	3,247	4.2%	1,425	1,102
All bikes	78,024	100%	2,795	2,315

Detour ratio between shortest and observed route

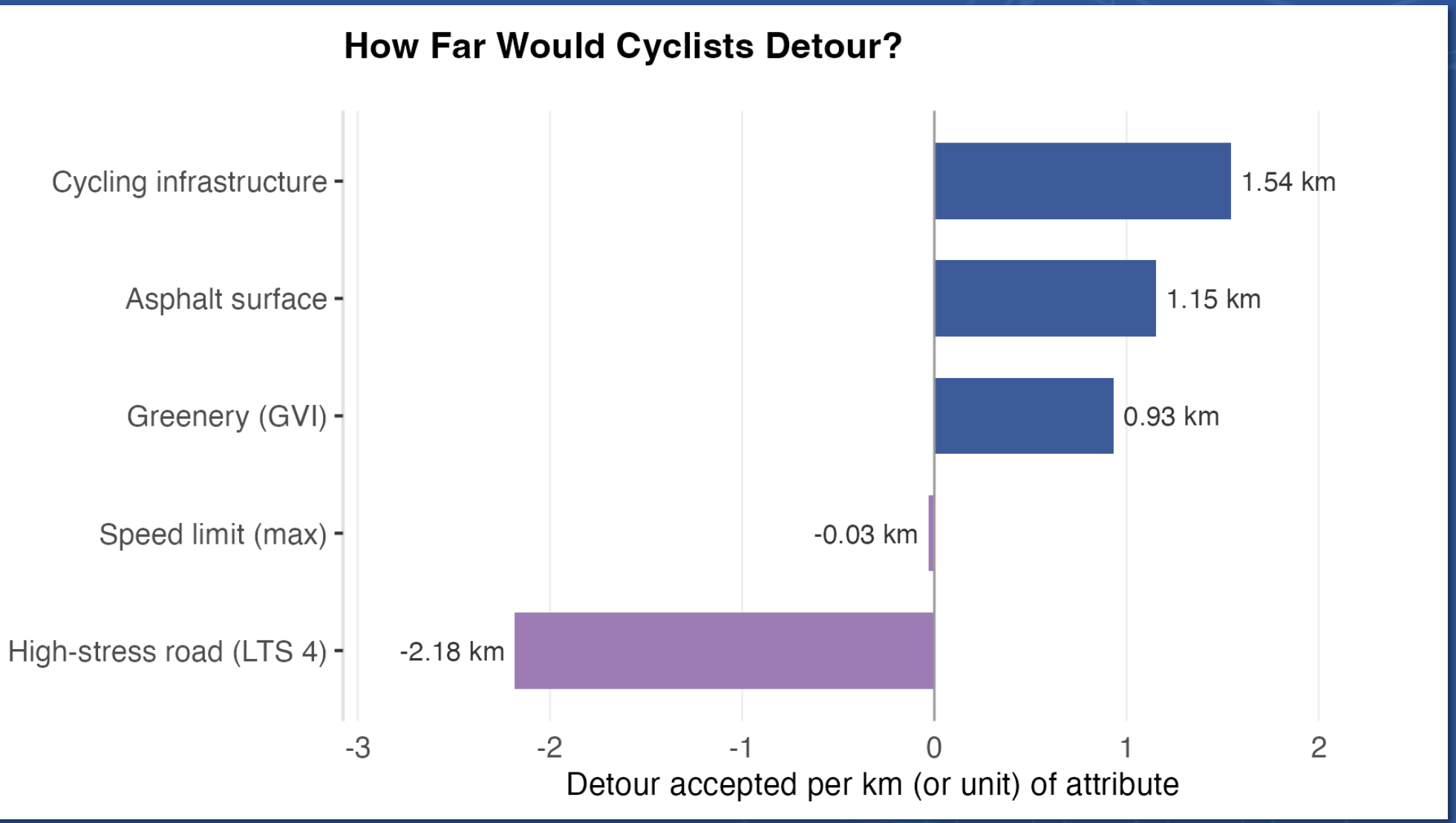
- On average, cyclists take 37% longer routes than the shortest alternative.
    - The median observed trip is 14% longer.
- 12% of trips have a detour ratio > 1.5
- Male cyclists tend to detour more than females (39% and 34%).
- Excluding trips with a detour ratio > 1.5:
    - Mean detour 1.15 (15%)
    - Median detour 1.12 (12%)





Detour by demographics

Bicycle type	Gender	Age group	Count	Avg detour
E-bike	Female	< 30	19,325	1.35
		30-49	9,248	1.31
		50+	4,308	1.4
	Male	< 30	37,141	1.4
		30-49	10,965	1.35
		50+	4,146	1.42
Regular bike	Female	< 30	646	1.25
		30-49	476	1.21
		50+	215	1.36
	Male	< 30	1,377	1.22
		30-49	573	1.25
		50+	210	1.44



N = 70,521

R^2 = 0.289

AIC = 212470.9

BIC = 212535.1

Segregated cycleway





On-street cyclelane

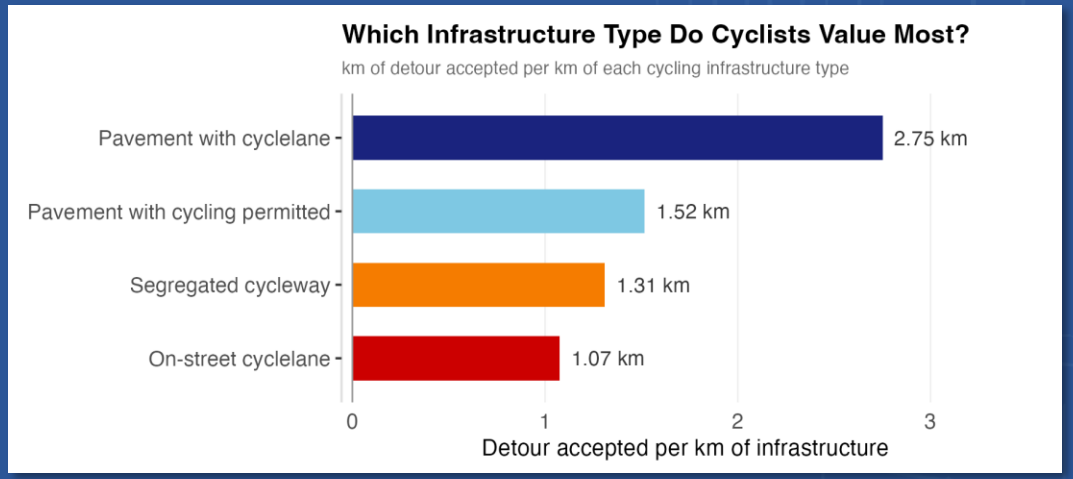


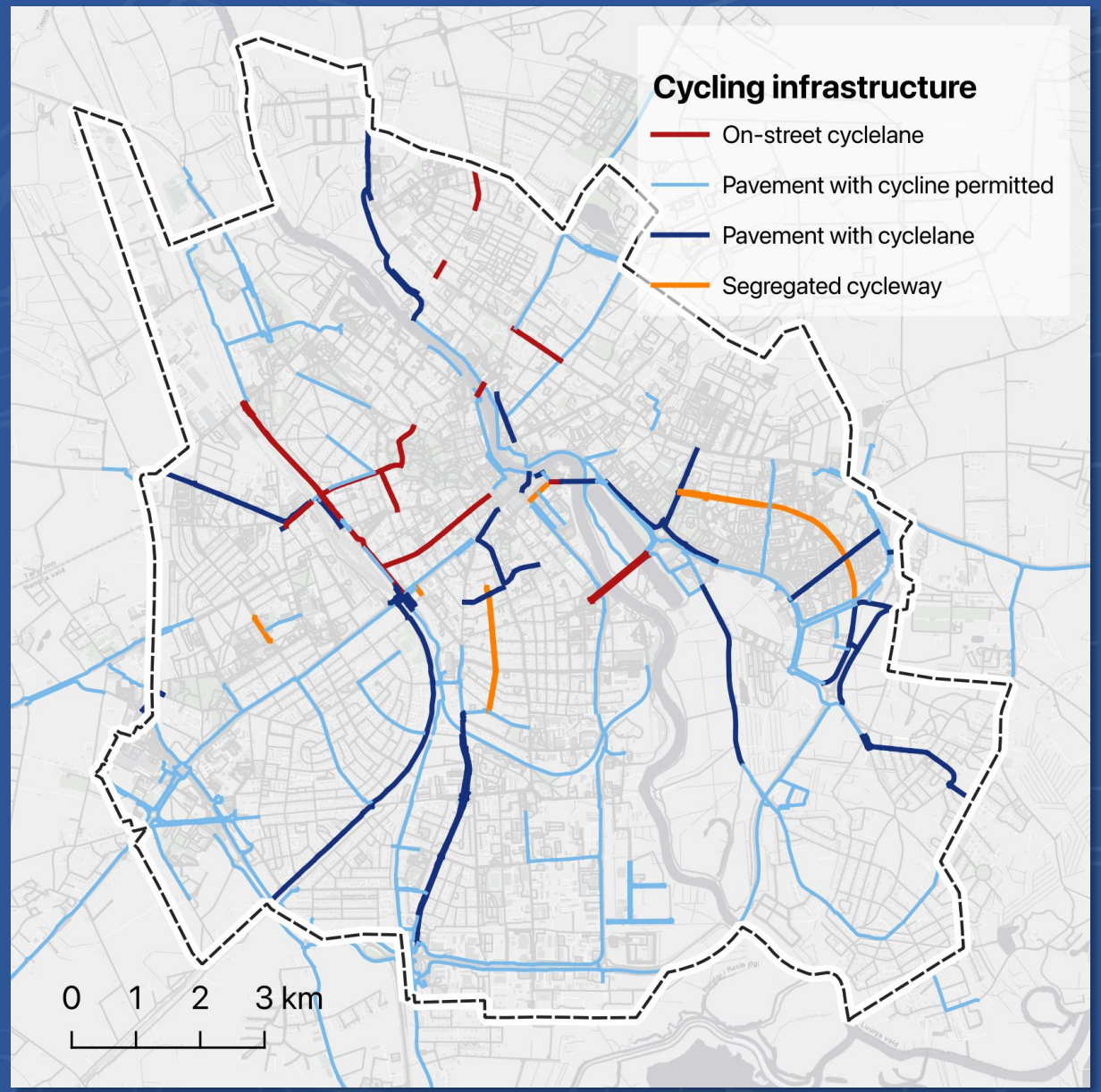


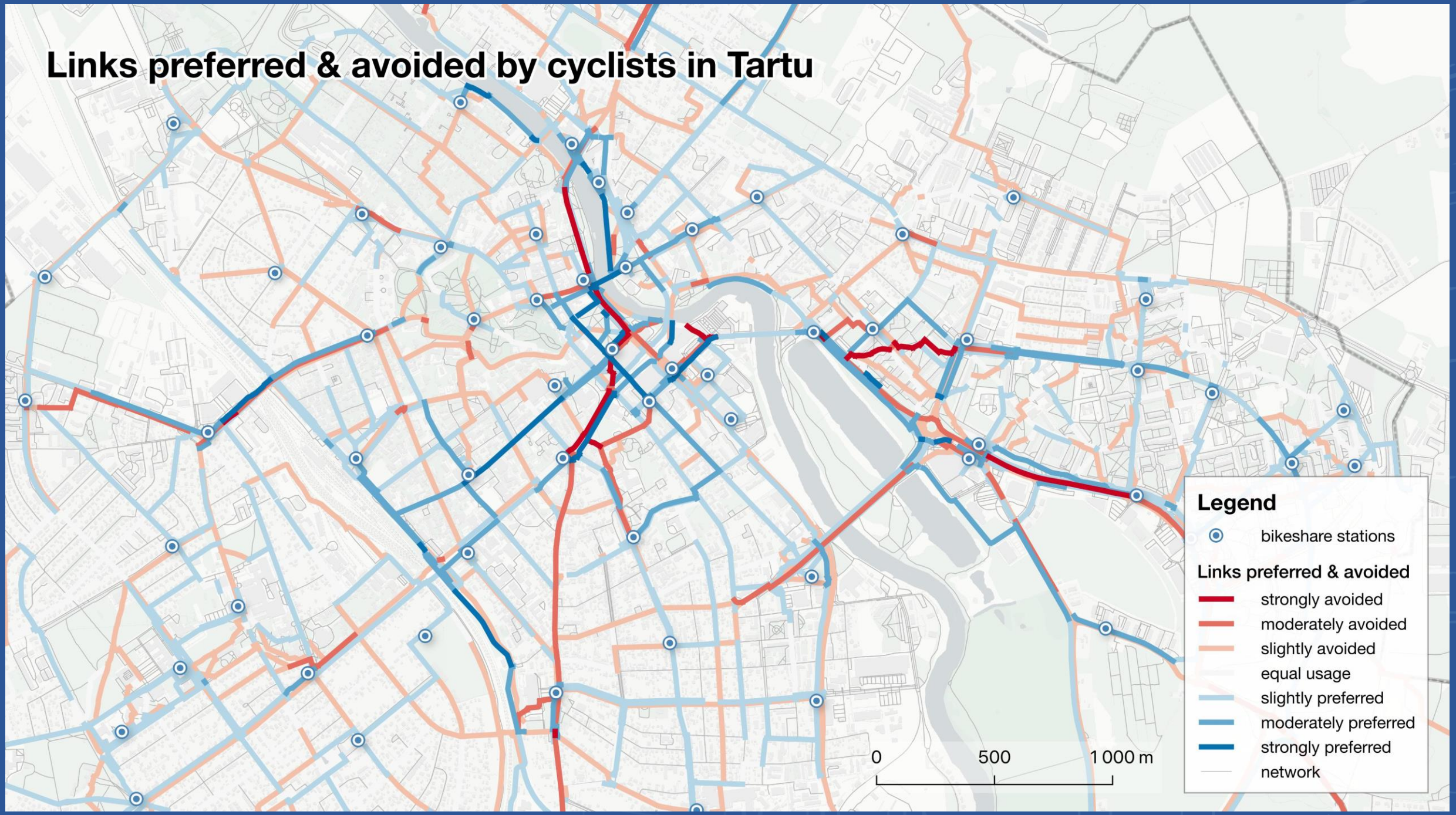
Pavement with cycling

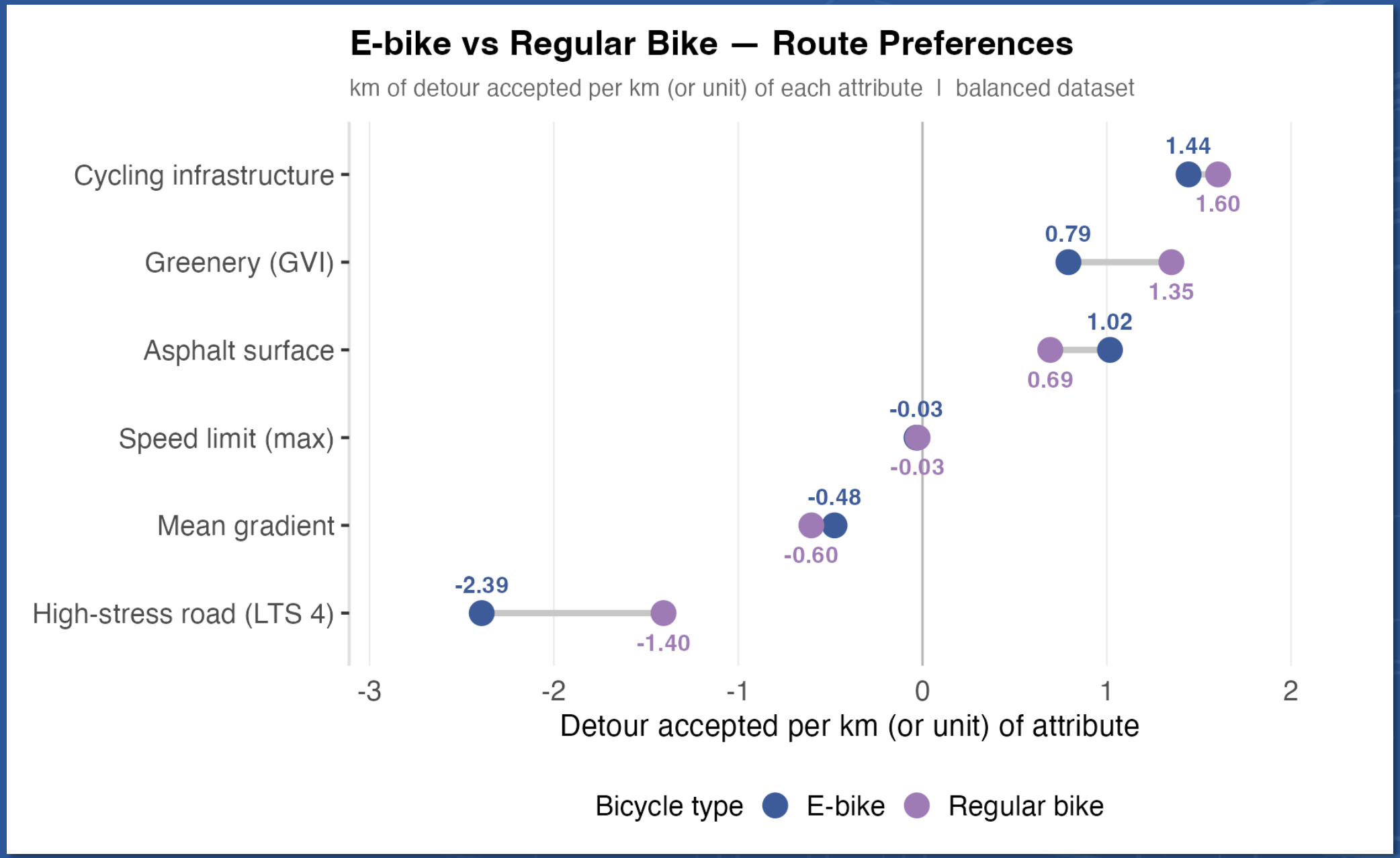









Links preferred & avoided by cyclists in Tartu
Legend
bikeshare stations
Links preferred & avoided
strongly avoided
moderately avoided
slightly avoided
equal usage
slightly preferred
moderately preferred
strongly preferred
network
0
500
1 000 m


E-bike vs Regular Bike — Route Preferences
km of detour accepted per km (or unit) of each attribute | balanced dataset
Cycling infrastructure
Greenery (GVI)
Asphalt surface
Speed limit (max)
Mean gradient
High-stress road (LTS 4)
1.44
1.60
0.79
1.35
1.02
0.69
-0.03
-0.03
-0.48
-0.60
-2.39
-1.40
-3
-2
-1
0
1
2
Detour accepted per km (or unit) of attribute
Bicycle type
E-bike
Regular bike

Conclusion and Further Research

- Cyclists actively trade distance for improved route quality.
- Roads with high levels of traffic stress are strongly avoided.
- E-bike trips are longer, larger detour ratio in comparison to the shortest alternative route, used for leisure trips.
- There are clear corridors preferred and avoided.
- The size of the dataset and the choice set generation is the main challenge.
- Inclusion of sociodemographic attributes.



Aitäh!


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IMPERIAL

Come visit Tartu and use the bike-share system and contribute to the data!

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