RAMBØLL

Bright ideas.
Sustainable change.

Modelling services for Cycling

BRUTUS by Ramboll & BRUTUS Lite for Cycling

Environmental Benefits
Almost every city has an emission target that they struggle to reach in mobility. Investing in cycling infrastructure is one of the most effective measures reducing greenhouse gas emissions and air pollution.

Economic Savings
Cyclists save money on fuel, parking, and vehicle maintenance. Cities can also reduce spending on road repairs and expansions since bicycles cause less wear and tear than cars. Promoting cycling tourism can boost local economies.

Traffic Congestion Reduction
More cyclists mean fewer cars on the road, which can significantly alleviate traffic congestion. This reduction leads to more efficient transportation systems and lower stress for commuters.

Community and Quality of Life
Well-designed cycling infrastructure contributes to the urban aesthetic and can enhance the sense of community. It provides inclusive and safe spaces for people to interact, contributing to social cohesion and overall quality of life.

Sustainable Urban Development
Integrating robust cycling networks into city planning fosters more sustainable and resilient urban development. It supports the shift towards low-carbon mobility and aligns with green city initiatives.

Public Health Improvement
Regular cycling promotes cardiovascular health, reduces obesity rates, and can improve mental health. Better cycling infrastructure makes it safer and more appealing for residents to choose an active mode of transport.

Advanced & Master Cycling Cities

Cities that have already made significant investments in a high-quality cycling network and often have a well-established cycling culture. Cities feature extensive and safe bike ways, parking facilities, and bike sharing systems.

Developing Cycling Cities

Cities that are in the early or developing stages of investing in cycling infrastructure. They are planning to do or implement a strategic plan that details the goals and steps necessary to create a network of cycling paths and routes to meet the needs of a city or region's population in the future.

Masters and advanced cities

Typical planning case of an advanced city:

- How to maintain the reached high modal share of cycling and yet still increase it?
- What is the impact of a new cycling investment such as a new cycling bridge or new bicycle path to cycling flows?
- How to improve bottle necks?
  - improving the existing segments on cycling network
  - Revealing missing links
- To know links with most cycling (in future)
  - need for additional space to allow free speed and safe takeovers?
- To know intersections with most cycling (in future)
  - need for additional space to avoid congestions, safety risks etc.
  - to solve biggest (total) delays?
- To find out which routes has potential to be “bicycle highways”
- How to support e-bikes as a new mode in addition to traditional cycling?

Example: BRUTUS Cycling model in Utrecht

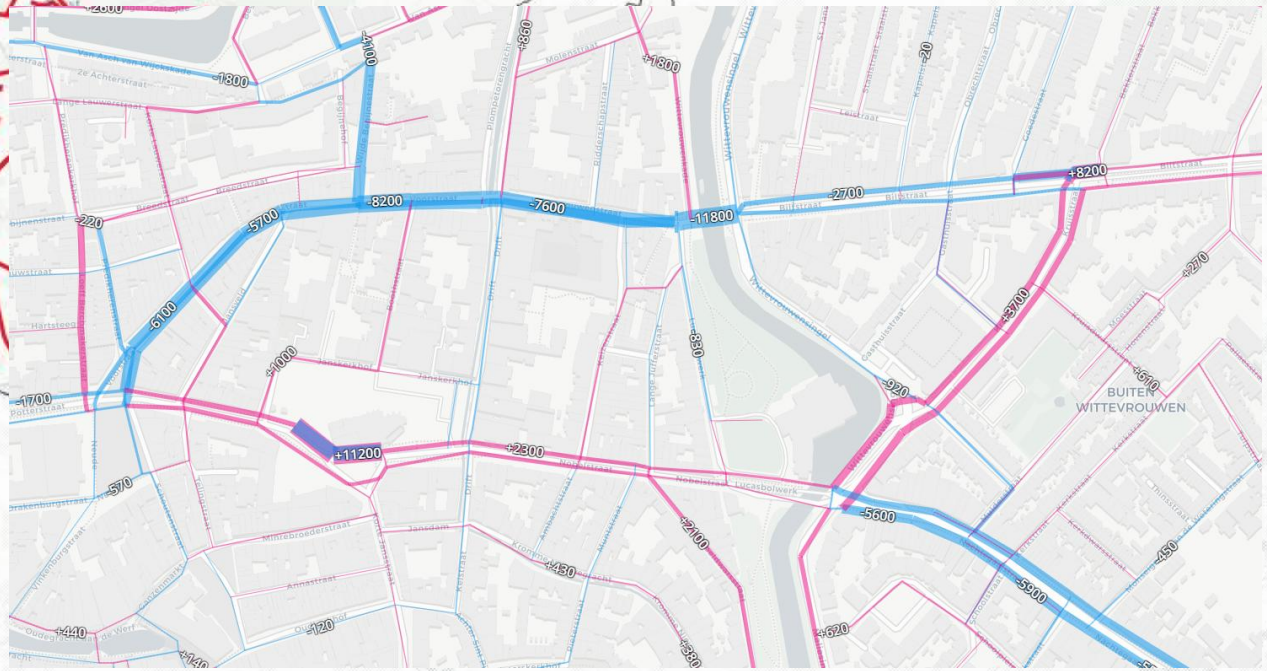
The Dafne Schippersbrug connects Utrecht's new district of Leidsche Rijn with the historic city center. BRUTUS correctly estimated the user potential of the bridge. A fact that was revealed by the automatic counters after opening.

In Utrecht, one of the leading cycling cities in the world, BRUTUS has helped policy makers and planners to evaluate a wide range of bicycle measures, ranging from improvements on small local cycling paths to the implementation of bicycle highways. The effects can be analysed in detail, focusing on for instance cycling volumes on specific routes or on certain user groups.

"For the province of Utrecht the use of the model is very fruitful, because it delivers insights in both regional level as on a local level for cycling. The interface was capable to deliver 80% of the questions often asked to transport models. The accuracy of the model was rather impressive, given the limited counting values available. In some projects we did counts, and the accuracy of BRUTUS was in these cases remarkably good. Not only the true numbers, but also the relative numbers for splits and joints. The scenarios give great tools to analyze possible interventions in the network, like missing links and additional land use."

Herbert Tiemens: Senior consultant Bike and Pedestrian for the City of Utrecht

Example: Modelling a set of measures in Utrecht



Because the network is so detailed, we can use it for many different policy measures. In the project picture we show the 165 different measures we have evaluated in one project. These were ranging from long new cycle paths to small upgrades on short streets.

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Example: Modelling a Cycling Tunnel in Helsinki

How much a short cut will help cycling? With at tunnel cost around 30 M€ we want to be sure the investment has good return. Brutus was used to estimate daily usage and showing changes in flows and also estimated benefitting users (range)

"With significant investments you want to be sure if it is worth building it. In this case we could show that it is not only people on bikes benefitting from the public investment – it is also the pedestrians in front of the railway station that will gain better city environment (less cycling passing by)

Niko Palo: ex-cycling specialist for the city of Helsinki

Example: Kulosaaren puistotie cycling estimate

2011

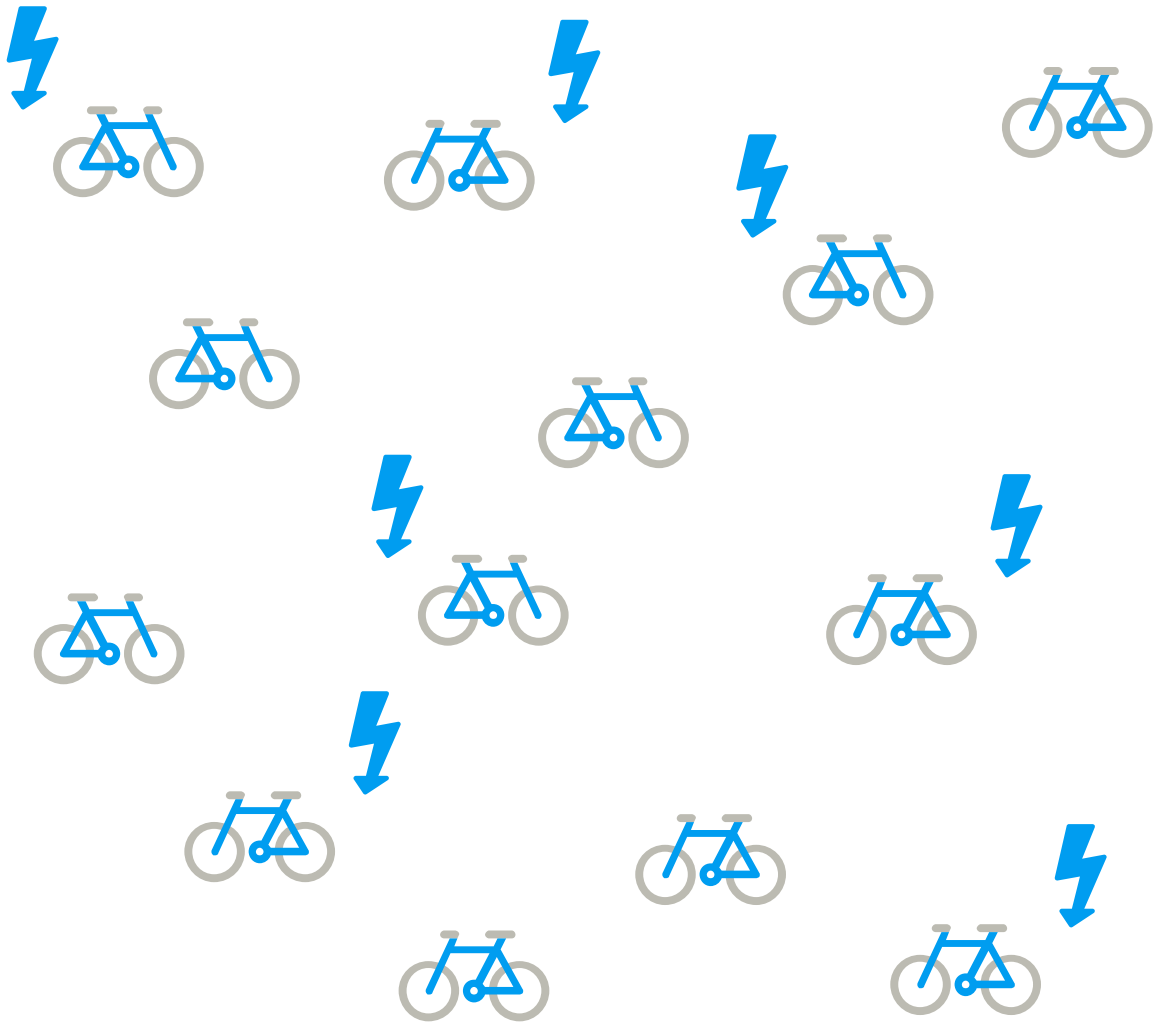
2023

Brutus was used to estimate the cycling volume in Kulosaaren puistotie in Helsinki. The segment is a part of the Eastern bicycle highway and pre-assumption was that cycling volume will rise in the future. Brutus helped to make the decision for the new layout for the plan. The existing bike way was way too narrow and dangerous, and thus the improvement was needed.

"There were two street layouts in the table and when considering the cycling volume and local pedestrian safety, we decided to build a bicycle street. The Brutus estimated volume of cycling was key measure in choosing the profile for this street"

Niko Palo: ex-cycling specialist for the city of Helsinki

Example: Potential e-bike cycling volumes



The e-bike is an emerging transport mode that can make cycling for more people more attractive, both for every-day travel and for longer cycling trips.

BRUTUS' advanced cycling simulation and detailed agent characteristics make it possible to study the potential e-bike usage under various penetration rates.

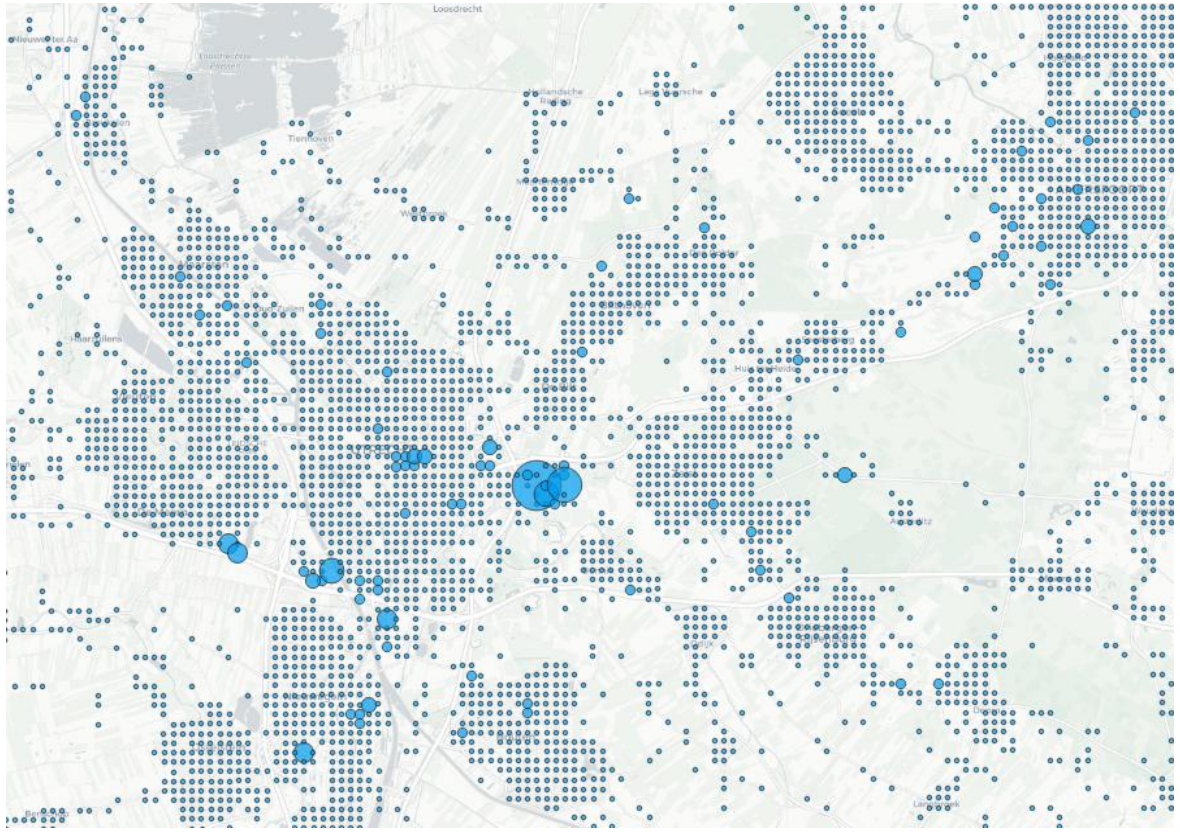
We determine where in the network e-bikes can reach higher speeds and use that information together with e-bike user profiles to simulate e-bike travel with different penetration rates.

This allows to understand e-bike travel between different areas and where e-bikes cycle in the road network.

We have used this methodology successfully in Utrecht, The Netherlands to study e-bike cycling potential between different municipalities.

Ramboll just ordered and guided a Master's Thesis on the topic: *Pelletier R. 2024, Modelling Transport Demand for E-bikes. Master's Thesis in Computational Science and Engineering, Technical University of Munich.*

Example: E-bike charging demand



Parking demand for e-bikes in the city of Utrecht.

E-bikes can be an important mode for making urban transport more sustainable. Cities try to facilitate this by providing public charging infrastructure. Knowing where to put chargers is challenging for cities as demand it not yet clear.

With BRUTUS, cities can understand how people will travel with e-bikes and what demand they have for charging. In this way, cities can efficiently facilitate the growth of e-bike usage.

We use existing data on e-bike ownership and expert input to understand how the e-bike will be used and by which user groups.

We can then simulate how each e-bike is likely to travel through the transportation network.

From this simulation we can derive where somebody would like to park his or her e-bike and how much charging is needed.

Example: Single missing link

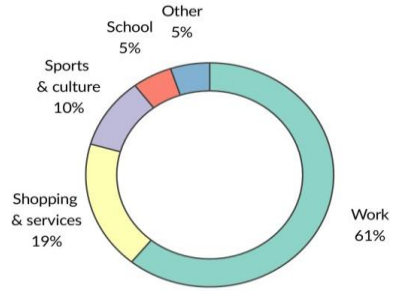
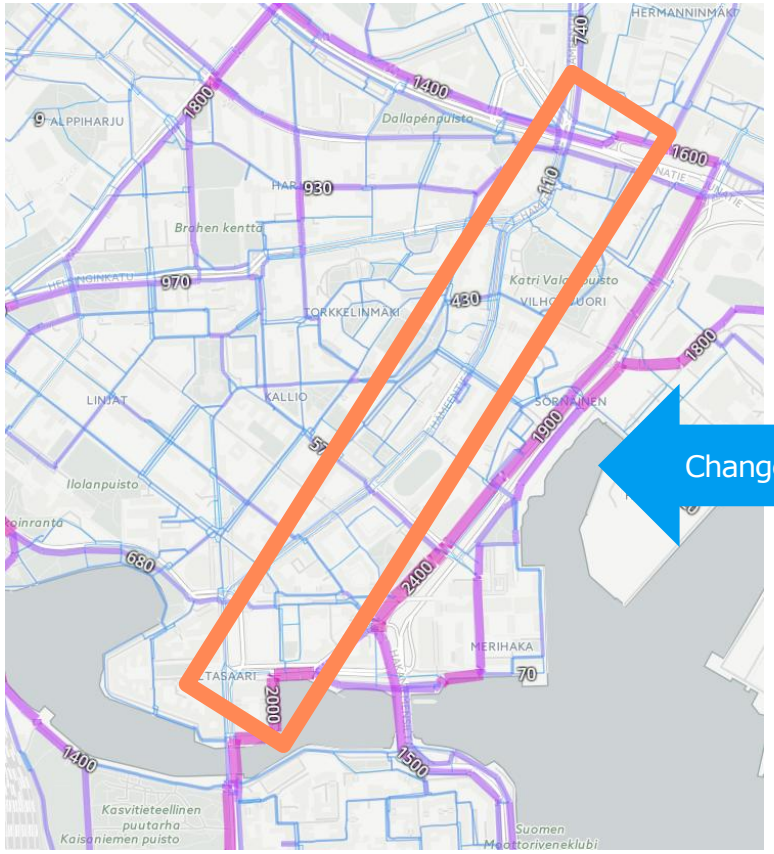


Image courtesy of City of Helsinki

BRUTUS was used to evaluate impacts of developing a street section (Hämeentie) on cycling routes and impacts on different user groups.

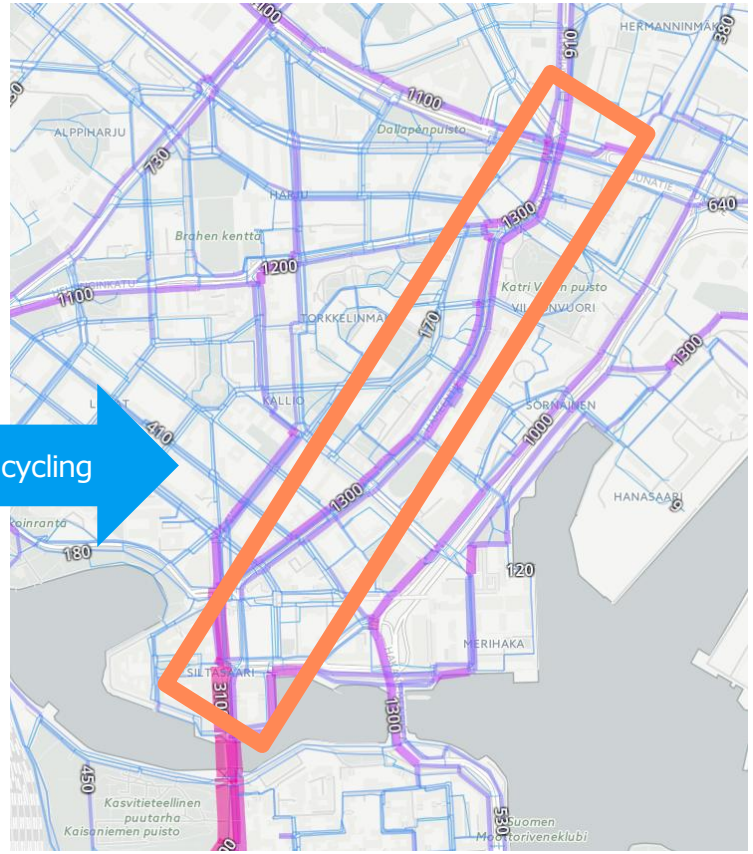
"The common presumption is that bicycle paths are not needed because there are no cyclists. Brutus can reveal cycling potential in the scenario, where all streets have safe cycling conditions. With this information, we could proceed with a plan and eventually built bike paths on Hämeentie."

Niko Palo: ex-cycling specialist for the city of Helsinki



Before

Changes in cycling



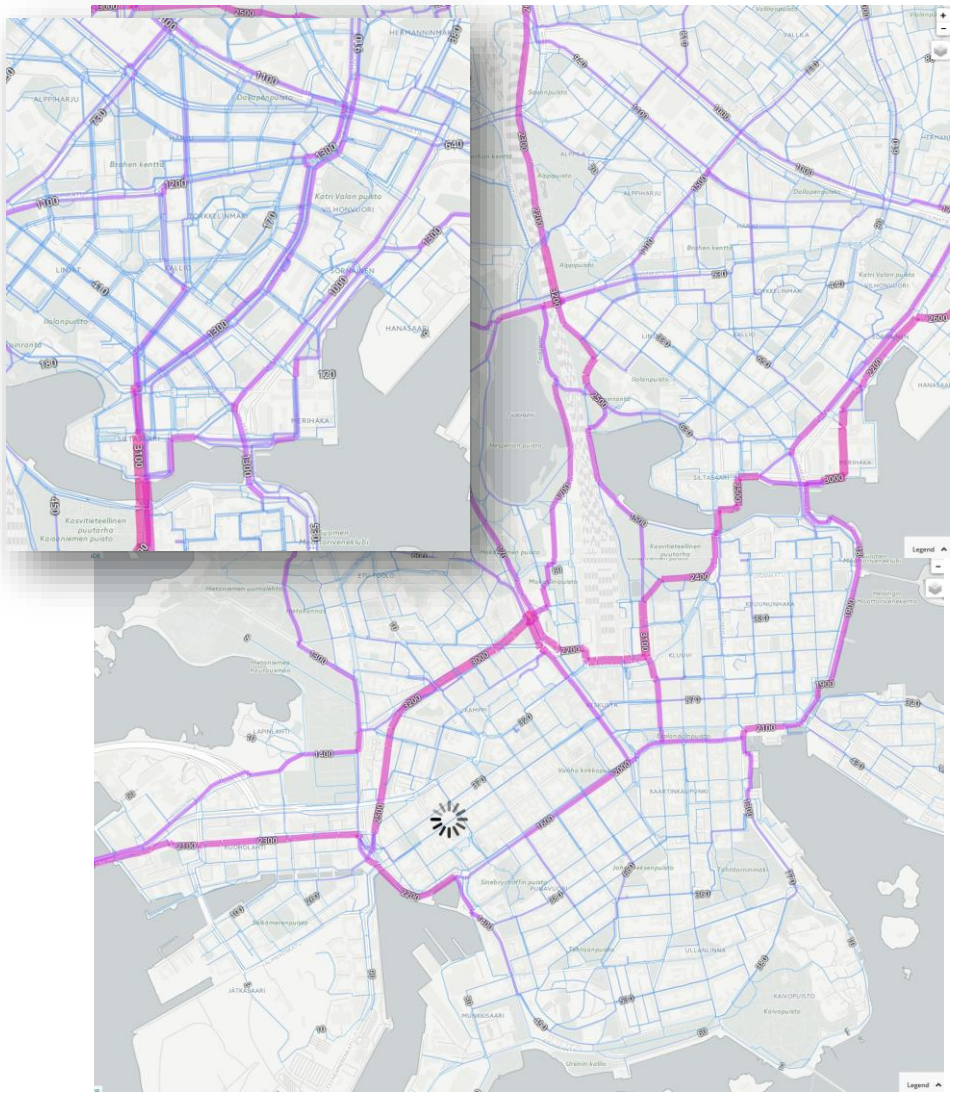
After

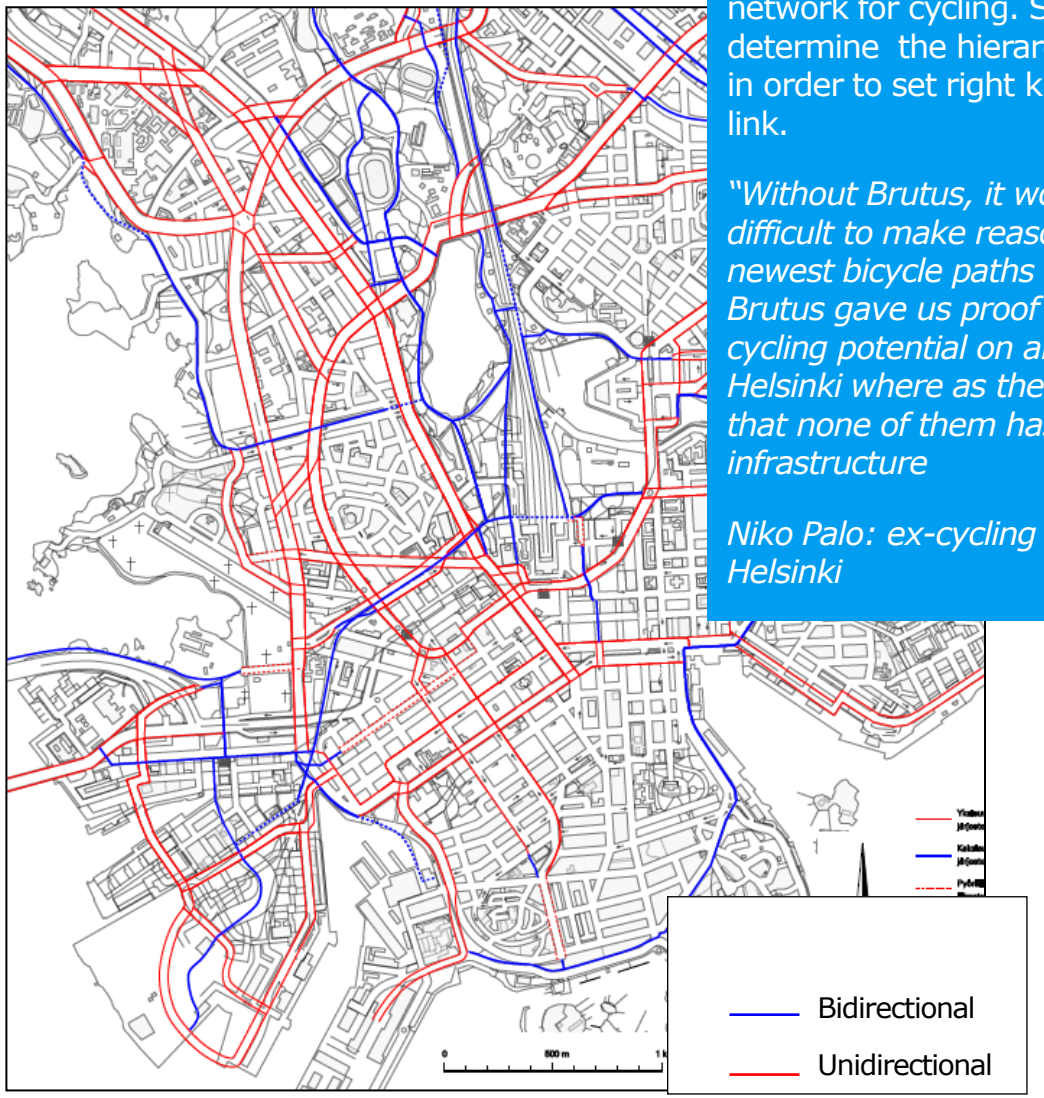
Developing Cycling Cities

Typical questions of a developing cycling city:

- To show cycling potential in political discussion
- What kind of mode share can be expected if cycling infrastructure is improved by the year x with an investment rate of y.
- What is an optimal comprehensive network plan, regardless of existing cycle way segments
  - trials of different investment levels and achieved network improvement in future
  - revealing missing links
  - to help in planning for comprehensive plan and
  - create hierarchy for cycling network
  - support its political acceptance
- What scenarios could help reaching carbon neutrality goals

Example: Network planning in Helsinki





Brutus could support the city of Helsinki to develop the comprehensive network plan. First the brutus scenario showed a scenario, where each link is equally good for cyclist,and thus revealing the optimal network for cycling. Second stage was to determine the hierarchy for cycling network in order to set right kind of standard for each link.

"Without Brutus, it would have been really difficult to make reasoning for majority of the newest bicycle paths in central Helsinki. Brutus gave us proof that there is hidden cycling potential on all of the major streets in Helsinki where as the general assumption is that none of them has any need for bicycle infrastructure

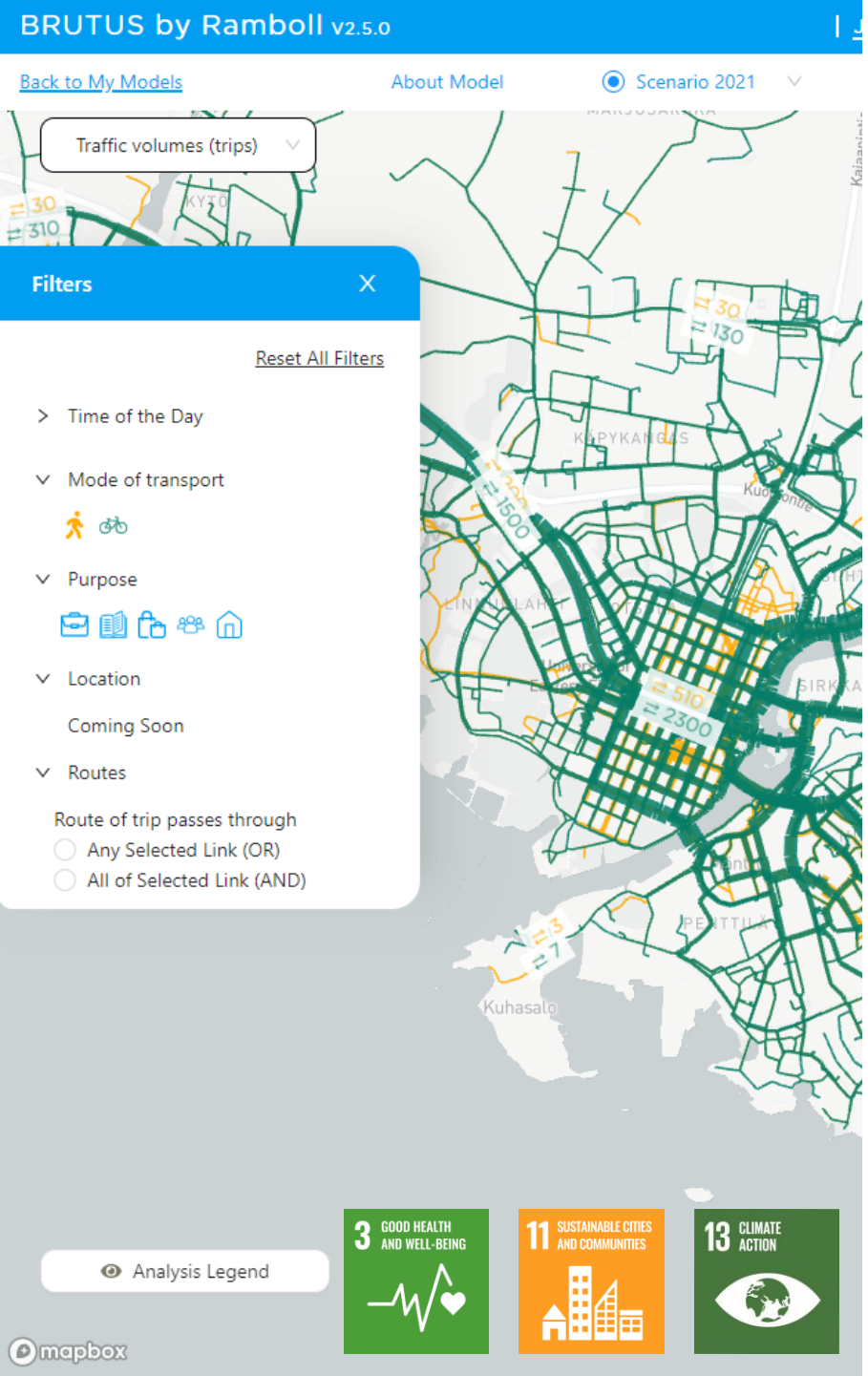
Niko Palo: ex-cycling specialist for the city of Helsinki

Example: Northern bicycle highway cycling volume estimate

Cyclists like it flat! Developing cycling infrastructure sometimes require flattening a surface. In this case the city of Helsinki came up with an idea to avoid a hilly section on Northern bicycle highway, and plan a new bike path along the railways. The Brutus was used to test the cycling volume on a flat ground. The model scenario was built to have a link which would follow the profile of the adjacent railways.

"Brutus was showing us an estimate of the increasing volume on this segment. Before building the peak volume was estimated to be 1355 cyclists per day. In 2024 the peak volume is 4287. without a support from brutus and its ability to understand inclines, it would have been challenging to explain all stakeholders why building this segment is so important."

Niko Palo: ex-cycling specialist for the city of Helsinki



A Pilot for modelling cycling flows - Finland

The challenge

Bicycle traffic has an important role in creating liveable places for people. Being able to understand the travel demand of cyclists and to evaluate the effect of different cycling infrastructure investments or policy measures is important for cities and regions to facilitate cyclists in the best possible way. Many public sector organizations rely almost entirely on bicycle counting data, which is gathered from very limited number of places. Even though such data is very useful, it is hard to extrapolate this data to represent the overall cycling situation in the whole network.

Our approach

The pilot project, in collaboration with Fintraffic, the state-owned Traffic Management Company, affirmed the effectiveness of our proprietary methodology to simulate the routes and volumes of cyclists everywhere on the network based on aggregated mobile network data.

Impact

Accessibility

- Test small interventions to improve cycling and walking to see impacts on accessibility.
- Prioritize safe and accessible pedestrian and bicycle paths, sidewalks, and crosswalks.

Efficiency

- Increase understanding of route planning and future cycling investment decisions
- Methodology is not reliant on transport modelling that often only larger metropolitan areas and regions can afford due to data requirements and funding resources.

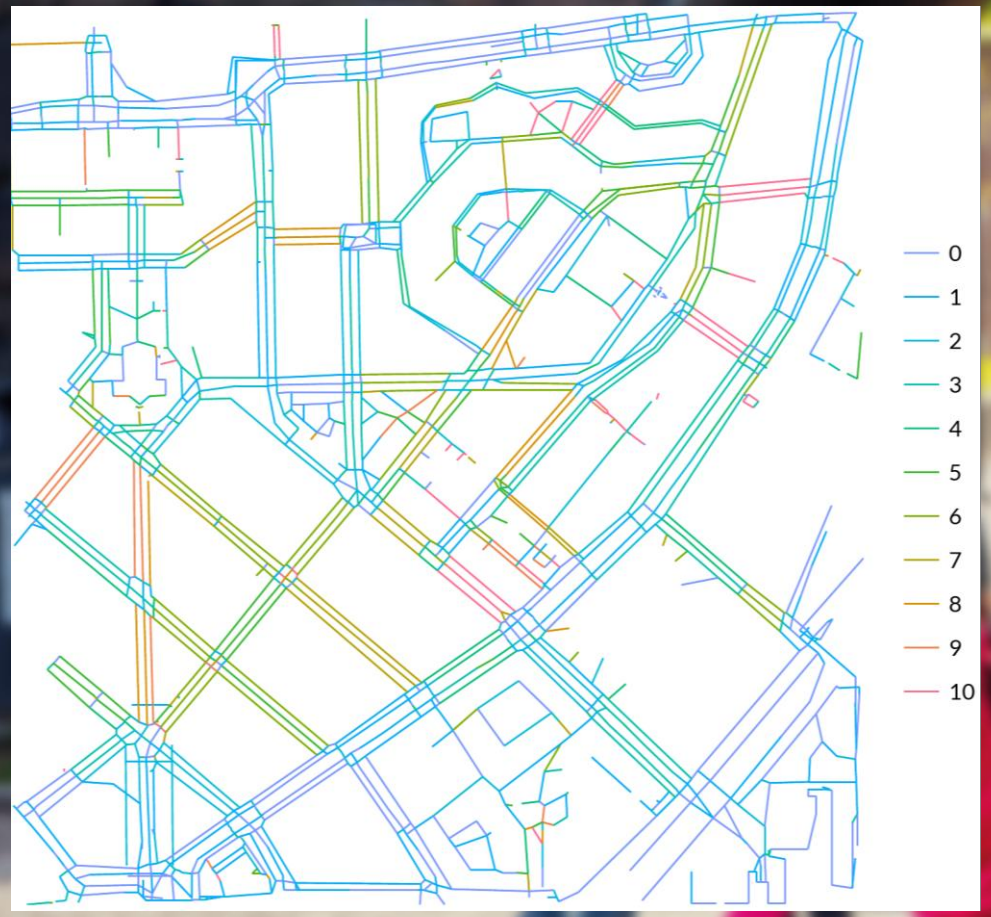
Safety

- Route and volume information can be used to plan traffic safety measures.

Green

- Being able to understand the travel demand of cyclists and to evaluate the effect of different cycling infrastructure investments or policy measures is important for cities and regions to facilitate cyclists in the best possible way

Example: Modelling the impact of slopes in Helsinki



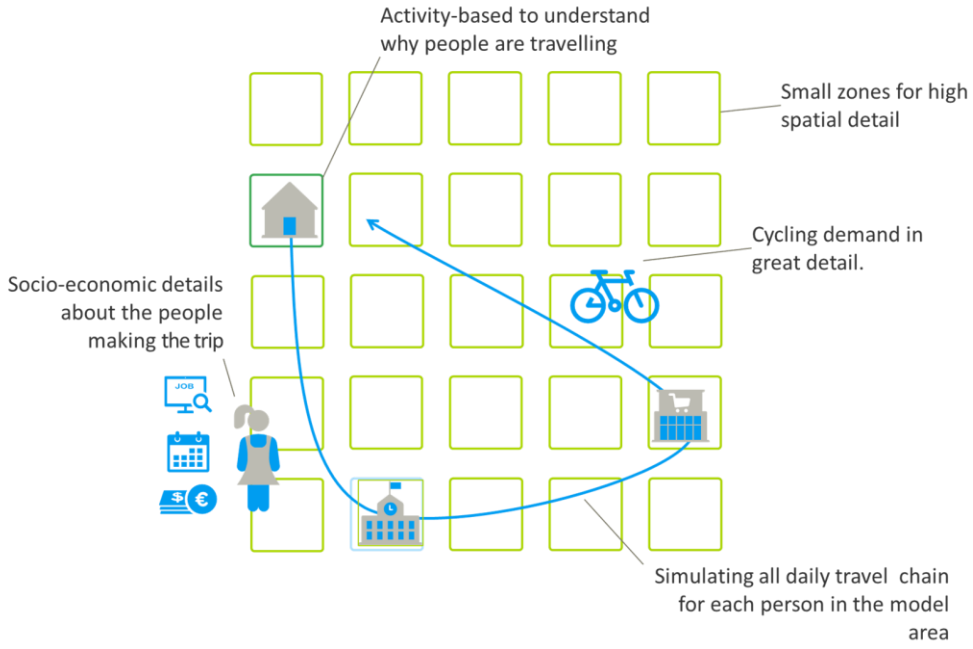
Grades (%) in Kallio, Helsinki

Our Modelling Tools

Ramboll have developed two modelling approaches that answer questions of both cycling-advanced cities and emerging cycling cities

BRUTUS by Ramboll is an activity-based travel demand model that simulates how people travel on a high spatial resolution and considers the individual characteristics of people.

BRUTUS provides highly detailed analysis of the effects of bicycle infrastructure investments. Travel demand is still modelled with a multi-modal modelling engine, but close attention has been paid to the network building and route choices for cyclists.



BRUTUS Lite for Cycling enables detailed cycling flow and route analysis in an instant to fulfil the need to have accurate and easy-to-implement decision-making support tools for bicycle infrastructure planning.

Detailed **cycling flow and route analysis** based on full BRUTUS methodology and multimodal modelling.

Use of **widely available and standardised data** makes application possible virtually anywhere.

Smaller regions without a traffic model and larger regions with only a traditional traffic model obtain cycling flow analysis capabilities.

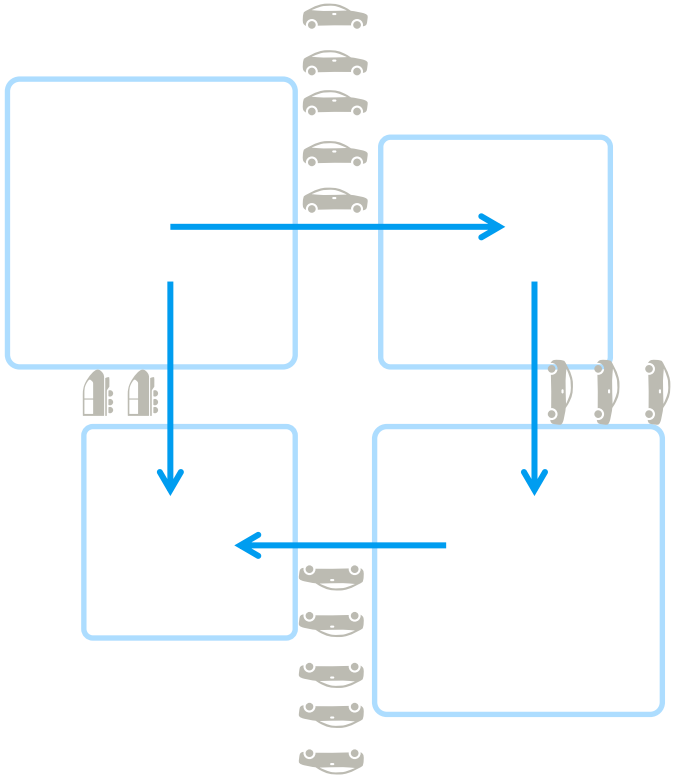
BRUTUS Lite is almost **instantly deployable** and enables utilization of modelling results even in ad hoc project cases.

BRUTUS vs. Traditional Models

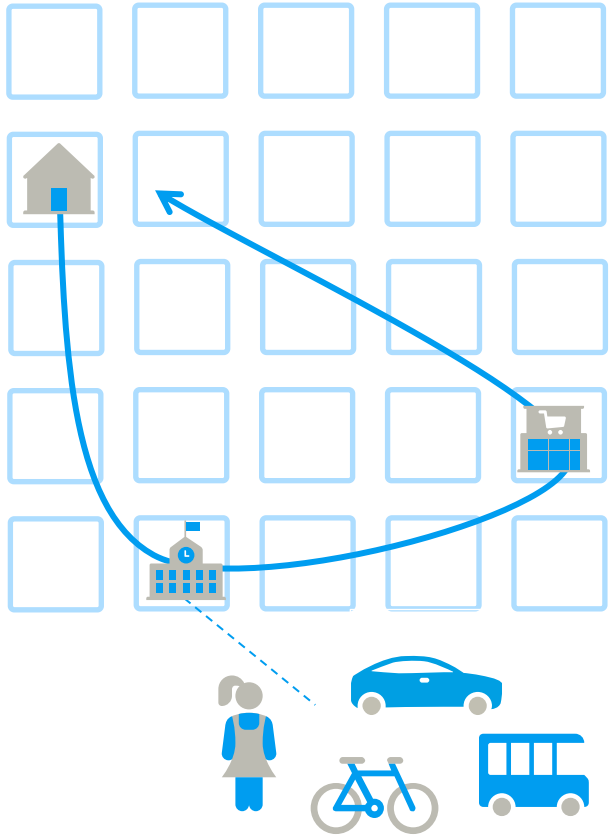
Most transportation models in use are traditional models. Such models calculate aggregate travel volumes between larger areas with no information about the trip individual people make. So, for example, you can calculate how many cars travel between area A and B, but the who and why is often unknown.

BRUTUS on the other hand takes the individual as the main decision-making unit, which makes it possible to take personal preferences better into account to highlight for example the distinction in mobility behaviour by gender. The BRUTUS approach leads to more accurate simulations both in results but also for spatially more detailed simulation, and for better analysis of the equity effects of transport policies. The result of a BRUTUS simulation is a detailed table that describes the travel and activity of each person in the model area.

Traditional model



Activity-based Model (BRUTUS)



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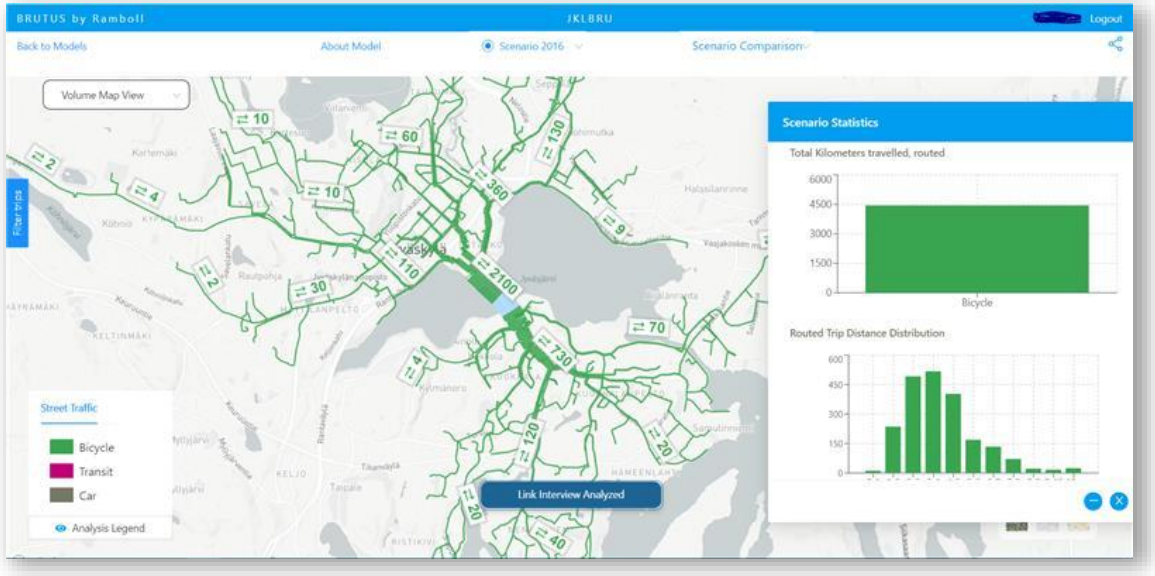
BRUTUS Lite for Cycling brings you..

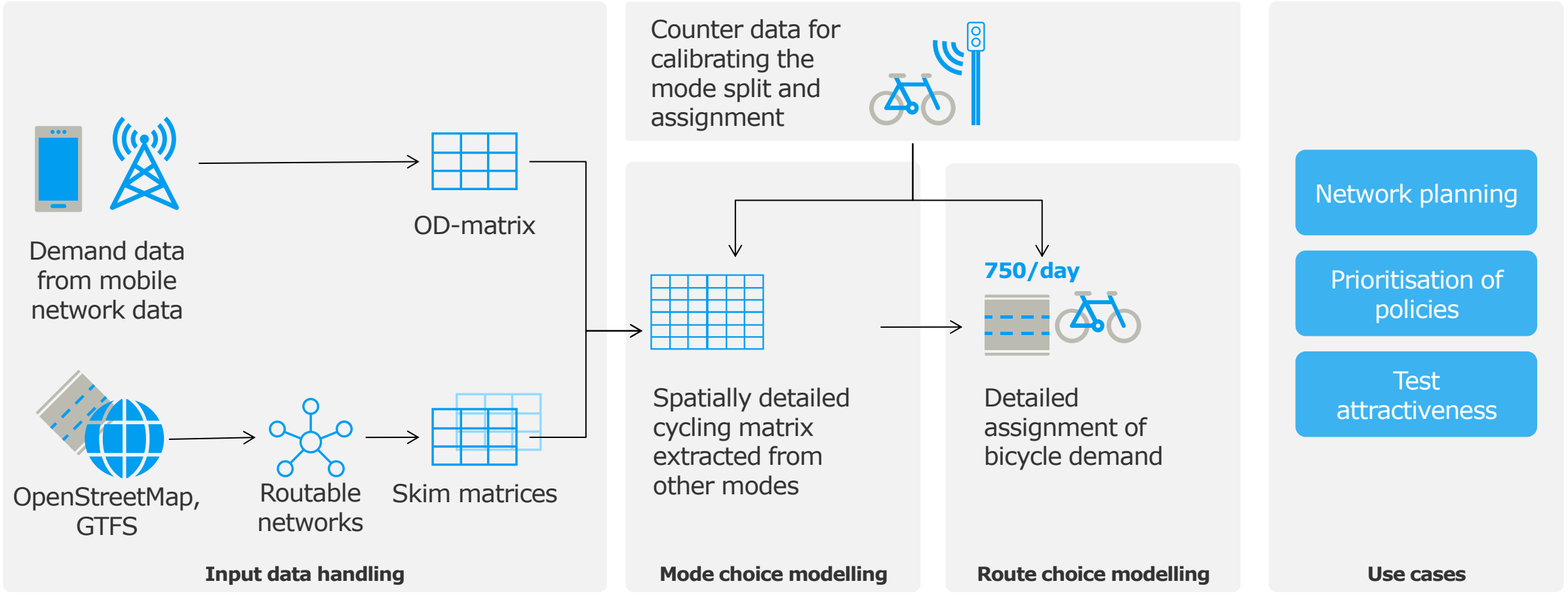
- Traffic flows on the network as a baseline information for bike network planning projects.
- Link-analysis and through-traffic analysis capabilities to study cycling flows.
- Impact analysis based on changes in the network structure and changes in routes taken by cyclists.
- Results can be analysed through an easy-to-use web-based viewer. No expert knowledge needed.

Additional possibilities:

- *Dynamically updating flows*
- *Socio-economic aspects*
- *Simple forecasts*
- *Upgrading to a full Brutus model*

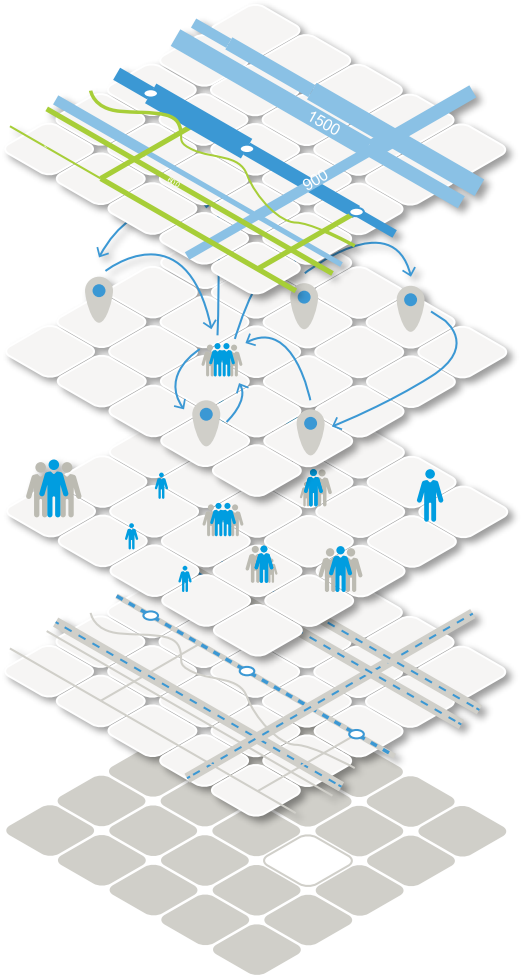


BRUTUS Lite Methodology



Appendix slides about BRUTUS

A State-of-the-Art Agent-based
Multi-modal
Modelling Engine



Modern Modelling Engine

Brutus is a individual-level simulation model, which is designed to meet today's design problems, making use of modern technical solutions and computing capabilities. Empirical models are applied using Random Utility Modelling to simulate single households' and individuals' decision-making situations.

In some use cases, travel demand is simulated in Brutus whilst the assignment on the network is handled by other more traditional and well established (aggregate) transport models like Emme or VISUM. In these hybrid models we can integrate Brutus with external tools and show results through Brutus UI.

Cycling and walking trips can also be extracted from Brutus to detailed microsimulation models such as Vissim.

How it works?

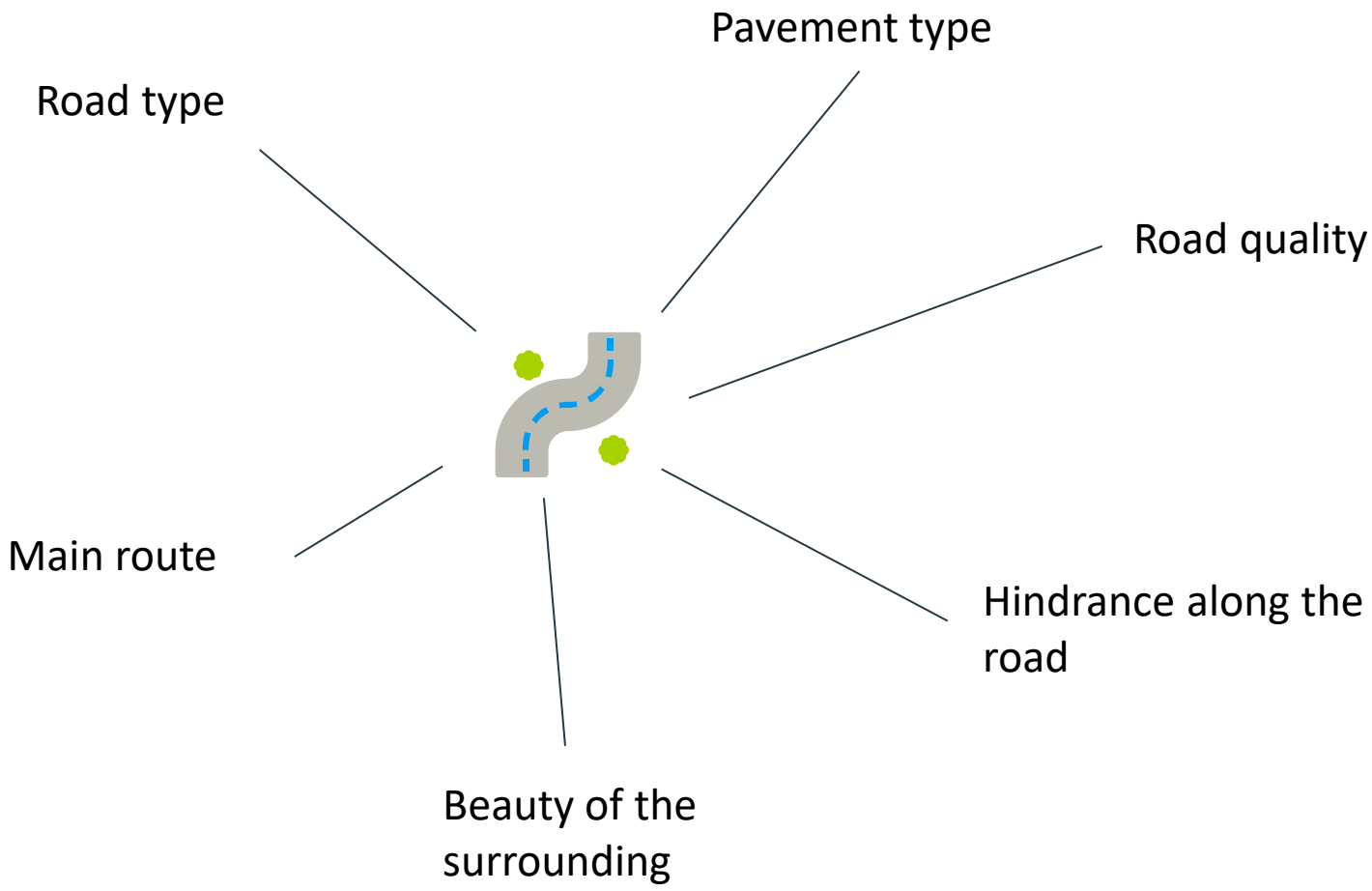
1. Brutus represents land-use in a dense grid containing information about socio-economic activities and population. Synthetic agent population is generated to closely resemble the study area population.
2. The grid cells are connected via a multimodal transport network that contains car roads, public transport lines and bicycle and pedestrian paths.
3. An activity pattern is generated for each person in the model. For that, travel survey data or data from a MaaS platform is used.
4. Traveling between activities is modelled as travel chains simulating a detailed activity diary of each agent.
5. All trips are assigned to the travel modes and routes that are most attractive in terms of time, cost and level of service.

Detailed network description

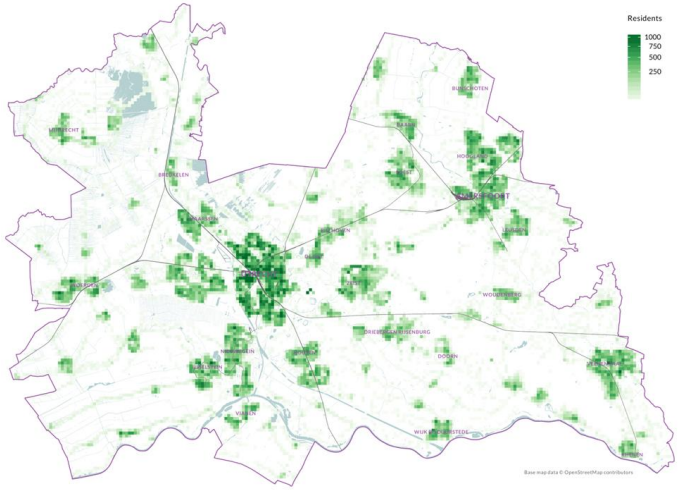
BRUTUS' detailed approach allows to better simulate bicycle and walking traffic and gives policy makers and planners more opportunities to test different measures.

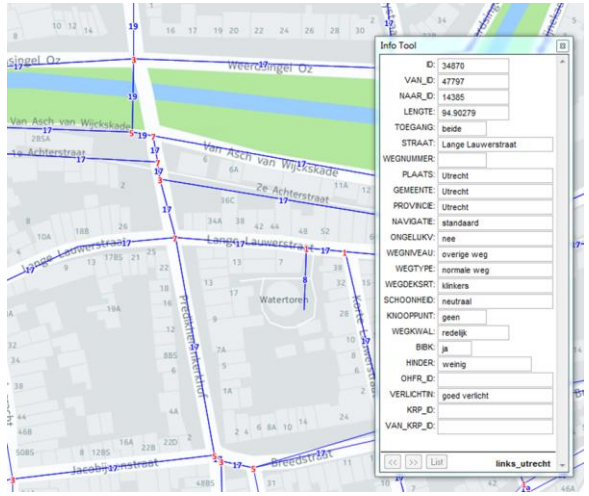
There are datasets available (such as OpenStreetMap or the Dutch Cyclist Union network) which contain a lot of variables which allows us to better take quality aspects into consideration in route choice and in determining the attractiveness of the bike.

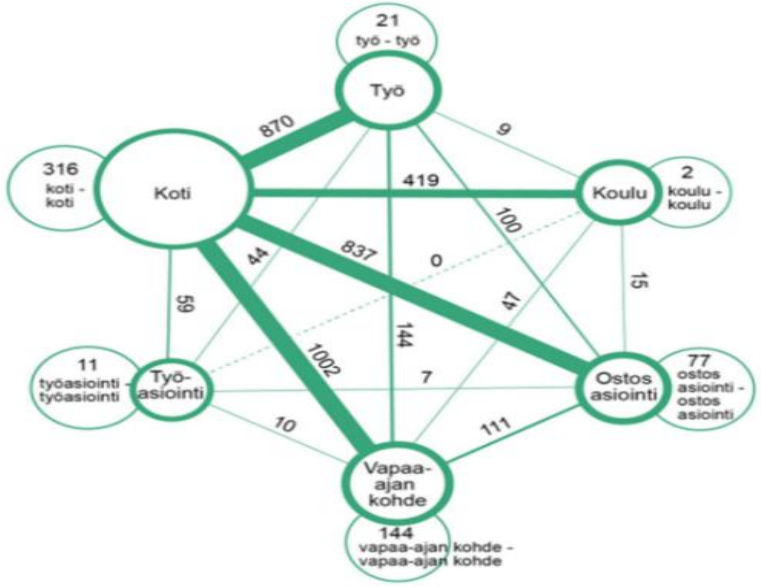
This makes simulations more precise but also broadens the things that can be tested in different scenarios



Data requirements







Land-use data with socio-economic characteristics of different locations

Network and transit timetable data (e.g. from OpenStreetMap, GTFS, other transport models).

Travel survey data

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eit Urban Mobility

Co-funded by the European Union

01	02	03	04	05
BRUTUS by Ramboll				
Utrecht	Copenhagen	Ghent	Amsterdam	Paris
71.1	70.8	67.6	66.6	65.0

06	07	08	09	10
BRUTUS by Ramboll	BRUTUS by Ramboll			
Helsinki	Münster	Antwerp	Bordeaux	Nantes
64.9	64.7	64.4	62.9	62.8

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