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Cycling modelling, on a shoestring

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Abstract

While the OTM and COMPASS models play a crucial role in cycling modeling within the Greater Copenhagen Area, their applicability outside this region remains limited. However, cities and regions beyond Copenhagen also require robust methodologies to support cycling infrastructure development, promote sustainable transportation, and enhance urban livability. To address these needs, Ramboll Finland has developed two innovative methodologies for cycling modeling: BRUTUS and BRUTUS Lite for Cycling. These models offer scalable, efficient, and high-resolution solutions tailored to the unique demands of regions outside Copenhagen, facilitating informed decision-making in cycling infrastructure planning and policy implementation.

Cycling modelling in Denmark

Active transportation modes like cycling are integral to creating liveable urban environments. Understanding cycling demand and evaluating the impact of infrastructure investments or policy measures are essential for cities and regions aiming to enhance cycling accessibility. While transport models play a crucial role in this process, many existing models primarily focus on motorized transport and do not adequately account for cycling and pedestrian flows.

Activity-based modelling approaches address these limitations by capturing detailed individual travel behaviours, such as trip chaining, time-of-day choices, and multimodal interactions, making them highly effective in analysing cycling as a transport mode. The COMPASS model (Copenhagen Greater Area Model for Passenger Transport) is an advanced activity-based transport model designed to facilitate multimodal analyses, including cycling (Paag, Kjems, and Hansen 2019). Similarly, the Ørestad Traffic Model (OTM), a four-step tour-based traffic model, has been improved to support bicycle modelling (Tønning and Vuk 2017). Despite their effectiveness, both models are primarily tailored to the Greater Copenhagen Area, limiting their direct application elsewhere.

As cities outside Copenhagen seek to increase cycling for sustainability and liveability, there is a pressing need for adaptable and resource-efficient cycling models. A key challenge lies in understanding cycling demand and identifying the most effective investments to achieve policy objectives. Ramboll Finland has developed two methodologies to address these challenges: BRUTUS and BRUTUS Lite for Cycling.

Lean activity-based cycling modelling

BRUTUS is a lean activity-based travel demand model that provides high-resolution insights through its fully integrated activity-based capabilities. Its streamlined and resource-efficient design makes it a practical and effective solution for diverse applications. The BRUTUS model has been widely utilized in Finland and has also been successfully implemented in the Utrecht region of the Netherlands, a global leader in cycling infrastructure. Given Utrecht's similarities to Denmark in terms of cycling culture, the BRUTUS model aligns well with Danish transport planning practices.

BRUTUS stands out due to its ability to simulate individual trip chains rather than aggregate traffic flows. Its spatial resolution is particularly high, with a 250-by-250-meter grid, ensuring precise analysis of cycling patterns, including short-distance trips often overlooked in conventional models. Every potential cycling route is incorporated, with detailed infrastructure attributes such as bike path quality.

The model has been applied to various studies, ranging from the planning of bicycle highways to small adjustments of local infrastructure: for example, an upgrade of a normal street to a cycling street. BRUTUS has also been incorporated in urban development planning, understanding the cycling demand of new urban areas where car ownership is heavily restricted. Or, it has been used to study the impact of roadworks on the surrounding network, allowing municipalities to plan for facilitating increased number of cyclists in surrounding streets to ensure efficient movement and safety of all road users.

Another important aspect of the model is how it is used by staff of municipalities or other regional public stake holders. Model results are available through a web-based UI, which does not require training. This makes the model be used by a broad range of users daily to check the situation around an area where they are undertaking a project, or to see how simulated measures impact traffic.

The characteristics of BRUTUS are crucial for understanding the needs of cyclists, since individual preferences are important, and trips undertaken by active modes are often taken places on shorter distances, e.g., in dense urban areas, for which the high spatial resolution of BRUTUS enables very detailed modelling. Travel demand is still modelled as multi-modal to get the modal shares to the correct level, but close attention has been paid to the network building and route choices for cyclists. In this way BRUTUS helps policy makers and planners to evaluate a wide range of measures, ranging from improvements on small local cycling paths, to the implementation of bicycle highways.

Cycling flow and route analysis in an instant

While comprehensive transport models like BRUTUS provide valuable insights, smaller cities and regions often lack the resources to develop full-scale transport models. To address this gap, Ramboll Finland has developed BRUTUS Lite for Cycling, an innovative tool that enables detailed cycling flow and route analysis in an efficient and accessible manner (Chen and Hollestelle 2023).

BRUTUS Lite for Cycling builds upon the methodologies of BRUTUS while prioritizing ease of deployment using widely available and standardized datasets. It employs proprietary methodologies to simulate cycling routes and volumes using aggregated mobile network data combined with network supply data from OpenStreetMap. Counter data is integrated for validation and calibration purposes.

The methodology follows these key steps:

An origin-destination-matrix with travel of people is obtained from the mobile network data. The data These datasets may have their limitations as the data has already been processed, aggregated, expanded

and anonymized by the mobile network operator. However, these data are generally well accessible without special data processing agreements.

The spatial resolution of the OD-matrix is increased to match the spatial granularity requirements of pedestrian and cycling traffic analysis. The method is based on combining two different mobile network data sources, OD-matrix with postcode accuracy and activities with grid resolution.

The market share of cycling between each OD-pair is identified by separating modes of transport from mobile network data. In the method, trips between each origin/destination pair are divided between different modes of transport based on the travel times of the modes of transport. Travel time is used instead of distance to increase the predictive value. Deterrence functions are based on passenger traffic survey data. The advantage of distance functions is a simple mathematical definition, making them easy to adapt to the current situation.

Once the previous methods have been used to create OD matrices separately for each mode from mobile network data, they are finally placed on the transport network to obtain traffic volume data. We can utilize assignment method already developed for activity-based model like BRUTUS by Ramboll or any other transport model. Counter point data is used to validate and calibrate the assignment result and traffic flows.

This approach has been successfully piloted in Finland in collaboration with Traffic Management Finland and the Finnish Transport Infrastructure Agency. It has been applied in client projects to map cycling and pedestrian flows, offering an accessible and efficient alternative for cities aiming to integrate cycling into their transport planning processes.

References

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