



A New Interactive Tool for the Holistic Evaluation of Multiple Aspects of the Transportation System

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Abstract. There are innumerable models within the transportation field, which offer a variety of detailed and specific analyses (e.g., traffic flow, fuel consumption, mode choice). However, to date there is an absence of a model providing a holistic understanding of the entire transport system. Existing models are reliant on simple assumptions outside of their specific focus to generate such system-wide results.

Against this background this paper presents a new interactive tool for the holistic evaluation of multiple aspects of the transportation system integrating research results from a variety of scientific disciplines and models. It aims to provide both a holistic understanding of the transport system and an interactive tool allowing the wider public to engage with state-of-the-art scientific research. For this purpose, it is based on a unique data eco-system that provides interfaces for transport demand, noise pollution, and emission models, and outlines the results of the model chain in an appealing and easily understandable manner.

This paper illustrates the features and the advantages of this new tool using the results of the project Connected Mobility for Liveable Places. The project aims to develop a people-centered, inclusive, and sustainable system of mobility of both people and goods.

Keywords: mobility lab · people-centered mobility · sustainable transport · models · data

1 Introduction

There is a wide variety of models and data sets used in transportation research at the moment differing considerably in granularity and scope. Model try to simulate a very specific part of reality as detailed as possible, but have to make very simple assumptions for things beyond its scope. In transportation research many models provide a detailed account of traffic flow, transport demand, fuel consumption, route choice, etc. However, due to the specific focus of each model, a holistic understanding of the transportation system is absent.

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C. McNally et al. (Eds.): TRAconference 2024, LNMOB, pp. 683–688, 2026.

https://doi.org/10.1007/978-3-031-88974-5_98

To address this need for a holistic understanding of the entire transportation system, a new modelling framework was developed and embedded in a unique showroom called the Mobility Lab. This showroom constitutes an interactive space for the visualization of scientific results allowing the engagement of the wider public. One of the key tools of the showroom is a portable touch table, which can be used to illustrate the modelling framework and its interactive nature at conferences, fairs, etc. This touch table will be used to present the Mobility Lab at the TRA 2024.

To illustrate the key features of the Mobility Lab on the basis of a concrete use case, it is applied to visualize the results of the project “Connected Mobility for Liveable Places” (VMo4Orte), which aims to develop a people-centered, inclusive, and sustainable system of mobility of both people and goods. More specifically, the Mobility Lab is used to present the modelled impact of redesign measures (e.g., such as road closures) in a neighborhood in Berlin, Germany.

2 Visualization: The Mobility Lab

The Mobility Lab aims to visualize the scientific results to foster the interaction of scientists with the broader public. For this purpose, the illustration of results not only has to be visually appealing, but also easily understandable and, more importantly, it has to enable the audience to examine the results on their own. Consequently, the Mobility Lab was designed in a way that invites anyone looking at it to interactively engage with the scientific results by selecting different scenarios, measures, models, etc. used in the visualization.

The Mobily Lab currently shows accessibility, noise emissions (from cars traffic), and routes for a multi-purpose autonomous vehicle (called U-Shift) for two scenarios. The U-Shift vehicle is capable of transporting six passengers or 24 parcels. The noise emissions are derived by a previously descried technique (3). The traffic is derived from the models TAPAS (1) and SUMO (2).

The visualization of the results of the VMo4Orte projects focuses on the impacts of the introduction of new bicycle lanes, roadblocks, and speed reductions in the neighborhood. The impact of these measures was investigated in term of the changes in accessibility metrics and noise pollution. In addition, the demand for an autonomous, driverless electric vehicle carrying both people and goods is illustrated on different routes through the neighborhood.

3 Data Source: The Connected Mobility for Liveable Places (VMo4Orte) Project

The VMo4Orte (5) project strives to develop transferable solutions that can be used to contribute to the sustainable transformation of the transport system. One part of the project focused on evaluating redesign measures in the neighborhood together with various stakeholders. This included transportation companies, public institutions and municipalities, and companies from the mobility and logistics sector.

The redesign measures include the implementation of diagonal barriers which serve as modal filters allowing access by bike and on foot but not by car, new bicycle lanes,

and speed reductions. The modal filters divide the neighborhood into 1–4 areas, which are closed to cars. The bicycle lanes were introduced on some of the main roads leading through the neighborhood, while the speed limit was lowered from 30 or 50 km per hour to walking speed on some road segments. Independently of these measures, the demand for autonomous, driverless electric vehicles (4) carrying both people and goods on different routes through the neighborhoods was simulated in a separate scenario.

The redesign measures were developed in dialogue with the stakeholders mentioned and implemented in an agent-based, microscopic transport demand model in order to analyze the potential effects on transport demand, traffic flow, and greenhouse gas emissions. By so doing the effects of the redesign measures on accessibility metrics and noise pollution in the neighborhood could be investigated and visualized.

4 Results

One problem in urban city planning is the usage of cars for very short trips, which could be easily replaced by foot or bicycle. However, dropping pupils off at school on the way to further activities is a common but from the point of road-safety in front of schools unwanted behavior. Figure 1 shows the impact of the redesign measures on the accessibility of primary schools by car in the neighborhood of interest. The Mobility Lab enables the users to examine this impact on accessibility on their own by allowing



Fig. 1. The impact of the introduction of diagonal roadblocks (red lines), lower speed limits (orange lines), and new bicycle pathways (green lines) on primary school accessibility. The blue dots mark the locations of the primary schools, while the color of the buildings indicates a reduced or improved accessibility of primary schools (white) by car through the introduction of the redesign measures. The image constitutes a screenshot of the Mobility Lab. The German Aerospace Center (DLR) holds all copyrights of the image.

them to switch between the visualization of the accessibility of primary schools by car in the baseline scenario without any redesign measures and the visualization of the accessibility in the redesign scenario with the measures implemented and shown on the map. A third view shows the difference in the accessibility, which allows see which regions are affected by the measures. Additionally, the measures can be shown to verify the effects of the results.

In particular for areas in the northwestern part of the neighborhood the accessibility of residents to primary schools by car declines through the introduction of the modal filters. This can be regarded as an intended effect as one of the main reasons for the implementation of modal filters is the motivation to reduce motorized traffic in the neighborhood and to encourage people to conduct shorter trips by active modes.

In addition, by changing the traffic volume, the redesign measures also have an impact on the noise pollution in the neighborhood as illustrated in Fig. 2. Mobility Lab users can interactively examine how noise pollution changes at different times of the day through the introduction of the redesign measures. For this purpose, they can choose between displaying the noise pollution with and without redesign measures for every 5 min of the day (Fig. 2a–c). For example, one can see the differences in the results on noise pollution in the morning and evening rush hour. Additionally, a total daily change in noise pollution can be displayed (see Fig. 2d).

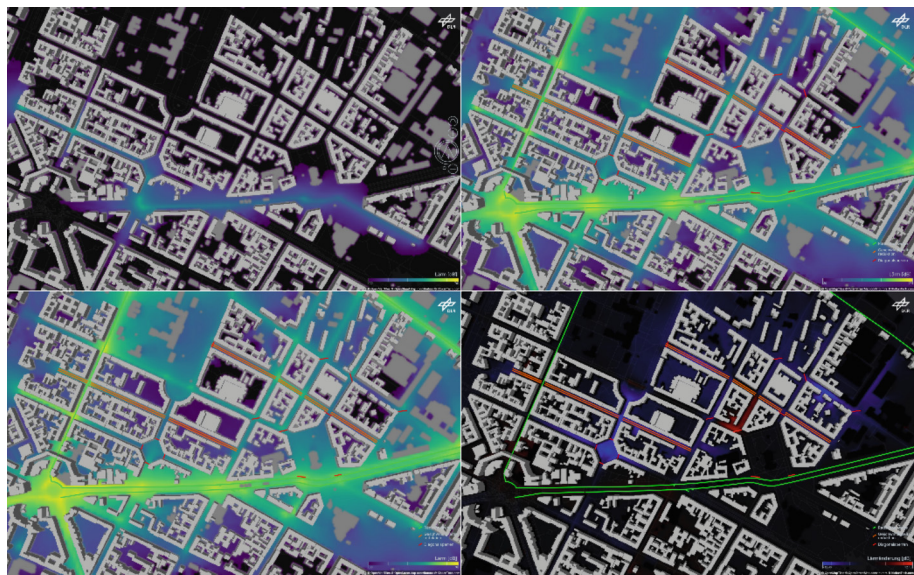


Fig. 2. **a (upper left):** The noise level at midnight in the baseline. **b (upper right):** noise level at noon with displayed measures (same as Fig. 1). **c (lower left):** noise level at 6pm with displayed measures. The noise pollution is depicted on a color scale from blue to yellow with blue areas indicating a lower level of noise pollution (30 dB) and yellow areas indicated a higher level of noise pollution (76 dB). **d (lower right):** total daily change in noise pollution due to the introduced measures. red: +12 dB, blue: –12 dB. The images constitute screenshots of the Mobility Lab. The German Aerospace Center (DLR) holds all copyrights of the images.

The strongest reductions of noise pollution are expected to occur in the areas immediately surrounding the diagonal roadblocks and on the street segments where the speed limit was lowered. Also, the introduction of bicycle lanes contributes to a small reduction of noise pollution along the main roads. However, some street segments see an increase in noise pollution through the redesign measures due to diverted traffic to avoid the diagonal roadblocks. This visualization result can help city planners redesign the measures to avoid design flaws before implementation.

Finally, Fig. 3 illustrates the potential route of an autonomous, driverless electric vehicle used for the transport of passengers in the neighborhood.

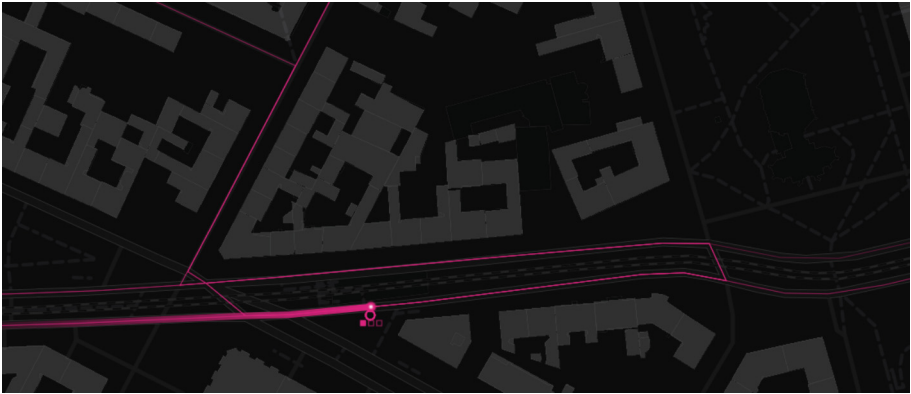


Fig. 3. The route of the U-Shift vehicle if used for the transport of passengers. The bright purple dot shows the position of the vehicle and the rectangles beneath its occupancy (1 square = 1 seat). The image constitutes a screenshot of the Mobility Lab. The German Aerospace Center (DLR) holds all copyrights of the image.

Mobility Lab users can examine the transport of goods by the U-Shift vehicle by clicking on “autoplay.” Then the vehicle starts moving through the neighborhood and it can be seen where it picks up and delivers goods. In addition, the users can switch the mode from “goods transport” to “passenger transport” and the vehicle starts moving through the neighborhood with passengers getting on and off in different locations. The visualization helps to identify critical movements like U-turns or frequent repetitions due to high demand and capacity constraints.

5 Discussion and Conclusion

The Mobility Lab visualizes a new modelling framework based on a holistic understanding of the entire transportation system. It enables the wider public to interactively engage with the scientific results of models (e.g., accessibility, noise pollution, autonomous vehicles). The non-scientific users of the Mobility Lab can easily examine what impacts the redesign of the transport system would have in each of these dimensions. Furthermore, it also supports decision-makers understand dynamic city planning.

In the future the Mobility Lab will be extended to include travel demand for additional cities and emission maps created to visualize climate and air quality impacts. Other topics, like spatial and temporal energy demand and storage capacity due to electric and hydrogen vehicles are planned.

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