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Towards Improved Traffic Impact Assessments for Construction Sites

Lessons Learned From Developing a SUMO-Based Prototype in Berlin

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Abstract. The coordination of construction sites in urban areas is increasingly critical to minimizing their traffic impact. Traditionally, traffic assessments were conducted late in the planning process, limiting opportunities for proactive mitigation. This paper presents a SUMO-based prototype that integrates the *Baustellenatlas*, a digital construction coordination tool, with *SESAM*, a cloud-based SUMO simulation service, via a REST API. The system enables automated traffic impact assessments, allowing users to modify road network properties and simulate their effects in real time. Two case studies in Berlin evaluated the prototype: a small-scale demonstrator at Molkenmarkt with randomly generated traffic and a larger, calibrated scenario at Tempelhofer Damm, reflecting real-world demand data. Results highlight the potential of integrating microscopic traffic simulation into early-stage construction planning, making data-driven assessments more accessible. Key challenges include the visualization of rerouting effects, long-term detour modeling, and expanding network modification capabilities. Future work will focus on public transport integration, adaptive signal control, and automatic scenario calibration using real-time traffic data.

Keywords: Traffic Impact Assessment, Construction Site Coordination, Microscopic Traffic Simulation, SUMO, SESAM, Baustellenatlas, Urban Mobility Planning, Rerouting Strategies, REST API Integration

1. Introduction

The execution of large construction projects in urban areas increasingly impacts traffic conditions. Historically, traffic impact assessments for construction sites were performed during late planning stages, often as part of the permit approval process. Given the rising number of construction sites and pre-existing congestion in cities, this approach is no longer sufficient. Effective coordination requires integrating traffic impact analysis into early planning stages, , involving all relevant stakeholders. However, existing tools often lack the ability to provide realistic, data-driven predictions due to the complexity of urban mobility and the expertise required to operate commercial traffic simulation software. Construction site effects—such as full or partial road closures, lane reductions, and interactions between multiple projects—are difficult to quantify without simulation-based methods. To address this, we developed a prototype that links the *Baustellenatlas* (BSA), a construction coordination platform, with *SESAM*, a cloud-based SUMO Web Service for Eclipse SUMO, via a REST API. This integration enables automated traffic simulations based on real-world construction site data, allowing planners to evaluate the effects of modifications such as lane reductions, road closures, and speed limit changes. The prototype was tested in two case studies in Berlin: a small-scale scenario at Molkenmarkt, which provided a quick and demonstrative test environment using randomly generated traffic, and a more complex scenario at Tempelhofer Damm, which was calibrated using real-world traffic demand data from Berlin's daily traffic volumes. By embedding microscopic simulations in a practical planning tool and the possibility of its application in a touch table, this prototype helps different kind of stakeholders to collectively identify construction site concepts with minimal impact on traffic flow. However, challenges remain, including improved visualization of rerouting effects, handling long-term detour adaptations, and expanding modification capabilities for signalized intersections. The following sections present related work, describe the system architecture, detail the case study evaluations, and discuss lessons learned and future directions.

2. Related Work

Traffic impact assessments for construction sites have been widely studied, particularly using microscopic traffic simulation tools like Eclipse SUMO [1]. Several research efforts have focused on integrating simulation frameworks with real-world applications to improve traffic planning and decision-making.

Fernandez et al. (2020) introduced Intas, a SUMO-based urban traffic simulation scenario for Ingolstadt, emphasizing the role of external influencing factors such as roadworks and weather conditions in altering traffic patterns [2]. Ribeiro (2023) proposed a methodology for automated road network modeling using digital twins and SUMO, demonstrating its applicability in real-time traffic analysis [3].

Hegde et al. (2022) focused on modeling cellular network infrastructure within SUMO, showcasing how urban environments can integrate simulation scenarios for roadworks and lane closures [4]. Chowdhury and Chakraborty (2023) further investigated the calibration of SUMO simulations for heterogeneous traffic conditions, which is essential for accurate construction site traffic flow modeling [5].

In addition to SUMO-based approaches, other simulation-driven methodologies have been developed to assess the impact of road disruptions. For instance, Marian et al. (2024) analyzed the vulnerability of road networks to flood-induced closures using a traffic simulation framework. Their study emphasized how traffic congestion is redistributed when key road links are unexpectedly closed due to extreme weather conditions [6]. Although not directly related to construction sites, their approach highlights the importance of evaluating network resilience under different closure scenarios, a concept that is also highly relevant in construction site impact assessment.

Similarly, Abbasi et al. (2024) explored optimization techniques for minimizing the impact of maintenance work zones in highway networks. Their study introduced a simulation-based framework for scheduling maintenance activities in a way that reduces congestion and travel delays [7]. This research aligns with our goal of integrating traffic simulation into proactive construction planning by helping decision-makers assess and mitigate disruptions caused by lane closures and detours.

These studies highlight the growing importance of integrating simulation-based tools with traffic management and construction planning to support data-driven decision-making in urban mobility. However, few studies have explicitly focused on the combination of SUMO-based simulations with real-world construction site impact assessments. This paper aims to bridge this gap by integrating the infrest *Baustellenatlas* with SUMO to facilitate automated, simulation-driven traffic impact analysis.

2.1 SESAM

SESAM [8] is a cloud-based platform for executing and analyzing SUMO-based microscopic traffic simulations. It provides an intuitive environment for running what-if mobility simulations and visually analyzing results through interactive map overlays and before/after comparisons. This enables users to quickly assess traffic changes and generate comprehensive reports for decision-making in urban mobility planning.

A key feature of *SESAM* is its visualization, which allows users to see vehicles moving in the simulation (see Fig. 1). This dynamic representation helps to better understand traffic flow, congestion hotspots, and the impact of different road configurations.

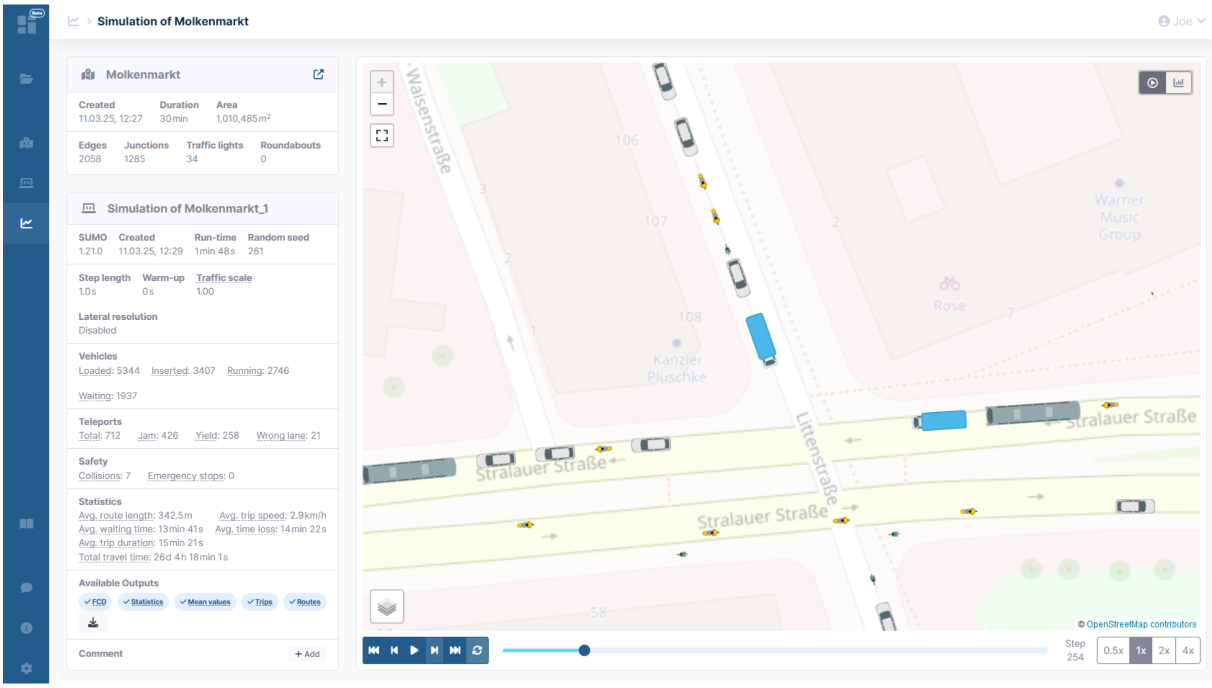

Figure 1. Visualization of SUMO-based traffic simulation results in SESAM.

SESAM offers two primary ways to create SUMO scenarios. The first approach uses the *Builder* component, which allows users to generate scenarios based on randomly generated traffic demand - similar to the *WebWizard* in SUMO. This enables rapid prototyping of different traffic conditions without requiring external input data. The second approach allows users to upload custom SUMO scenarios directly into their *Workspace*, making it possible to use pre-defined simulation networks and traffic demand models.

For developers and system integrators, *SESAM* provides a REST API for accessing its simulation capabilities and retrieving results programmatically. Detailed API documentation is available online [9], outlining methods for scenario creation, simulation execution, and result retrieval.

By leveraging SESAM, users can efficiently conduct cloud-based SUMO simulations, automate analysis workflows, and enhance their understanding of complex traffic dynamics through high-resolution visual outputs.

2.2 Baustellenatlas

The *Baustellenatlas (BSA)* [10] is a web-based platform for coordinating and planning construction activities in public road spaces. It enables municipalities, utility providers, public transport authorities, and construction companies to register, visualize, and manage planned and ongoing projects. By providing early-stage transparency and conflict detection, BSA helps to optimize construction planning.

The system features an interactive map interface (see Fig. 2) that displays construction projects, identifies overlapping roadworks, and facilitates coordination. Users can enter data manually via the web client, upload files, or integrate external sources through standardized interfaces.

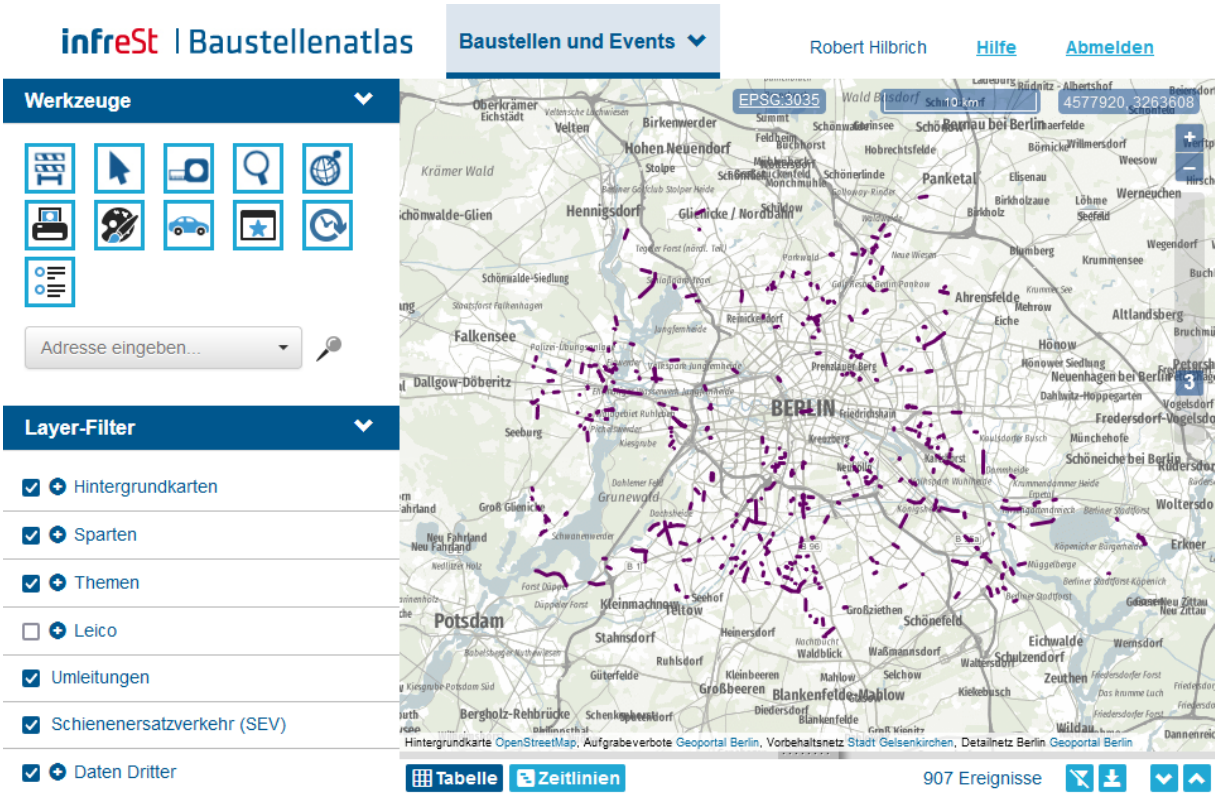

Figure 2. *BSA interface for the test system - test data - no real data.*

BSA users receive automatic notifications when construction activities overlap, allowing for early adjustments and better infrastructure coordination. The platform supports data export in multiple formats, ensuring interoperability with other planning tools. By acting as a centralized hub, BSA improves efficiency in construction planning and minimizes road congestion.

2.3 Workflow

The workflow is first described from the perspective of the usage of the REST API, detailing how construction site scenarios are processed and simulated in SESAM. This includes the interaction between the *Baustellenatlas* and SESAM, from scenario creation, its simulation to result retrieval. Afterward, the user interface of the prototype in the *Baustellenatlas* is introduced, illustrating how users interact with the system to configure scenarios and visualize simulation results.

2.3.1 API Usage

The interaction between the *Baustellenatlas* and *SESAM* follows a structured REST API workflow, as illustrated in Fig. 3. The process begins with the creation of a baseline scenario, which serves as a reference for subsequent simulations. This scenario is prepared in *SESAM* before any user interaction and represents the unmodified traffic conditions before construction site modifications are introduced.

When the *Baustellenatlas* connects to *SESAM*, it first performs a login request, granting access to the available simulation scenarios, including the baseline scenario. Through additional API requests, the *Baustellenatlas* retrieves relevant properties of the baseline scenario, loads the road network, and extracts existing simulation results for visualization in its user interface.

To assess the traffic impact of a planned construction measure, the baseline scenario needs to be modified. This is done by first duplicating the baseline scenario, ensuring that the reference remains unchanged. The duplicated scenario is then patched with the desired modifications, such as lane reductions, speed limit changes, or full road closures.

Once the modifications are applied, the *Baustellenatlas* triggers a new simulation run in the *SESAM* simulation platform. *SESAM* processes the request, analyzes the modified scenario and executes a SUMO simulation. During execution, the *Baustellenatlas* monitors the simulation status through periodic API requests. When the simulation is complete after a few minutes, the updated results, including key traffic indicators such as travel times and density changes on road segments, are retrieved.

Finally, the *Baustellenatlas* computes the differences between the modified scenario and the baseline scenario, enabling a visual comparison of traffic impacts directly in the frontend. This allows users to analyze the effects of their modifications and make informed decisions based on the simulation results.

2.3.2 User Interface

The user interaction in the *Baustellenatlas* follows a structured workflow that allows for the creation, modification, and analysis of traffic impact scenarios. To begin, the user creates a new scenario based on an existing one, typically using the *baseline scenario* as a reference. Once the scenario is created, the user can apply modifications to the road network to simulate the effects of planned construction measures.

As shown in Fig. 4, individual edges within the scenario network can be selected and edited. The available modifications in the prototype include:

- Lane reduction (e.g., reducing a three-lane road to a single lane)
- Lowering the maximum allowed speed
- Full closure of a road segment

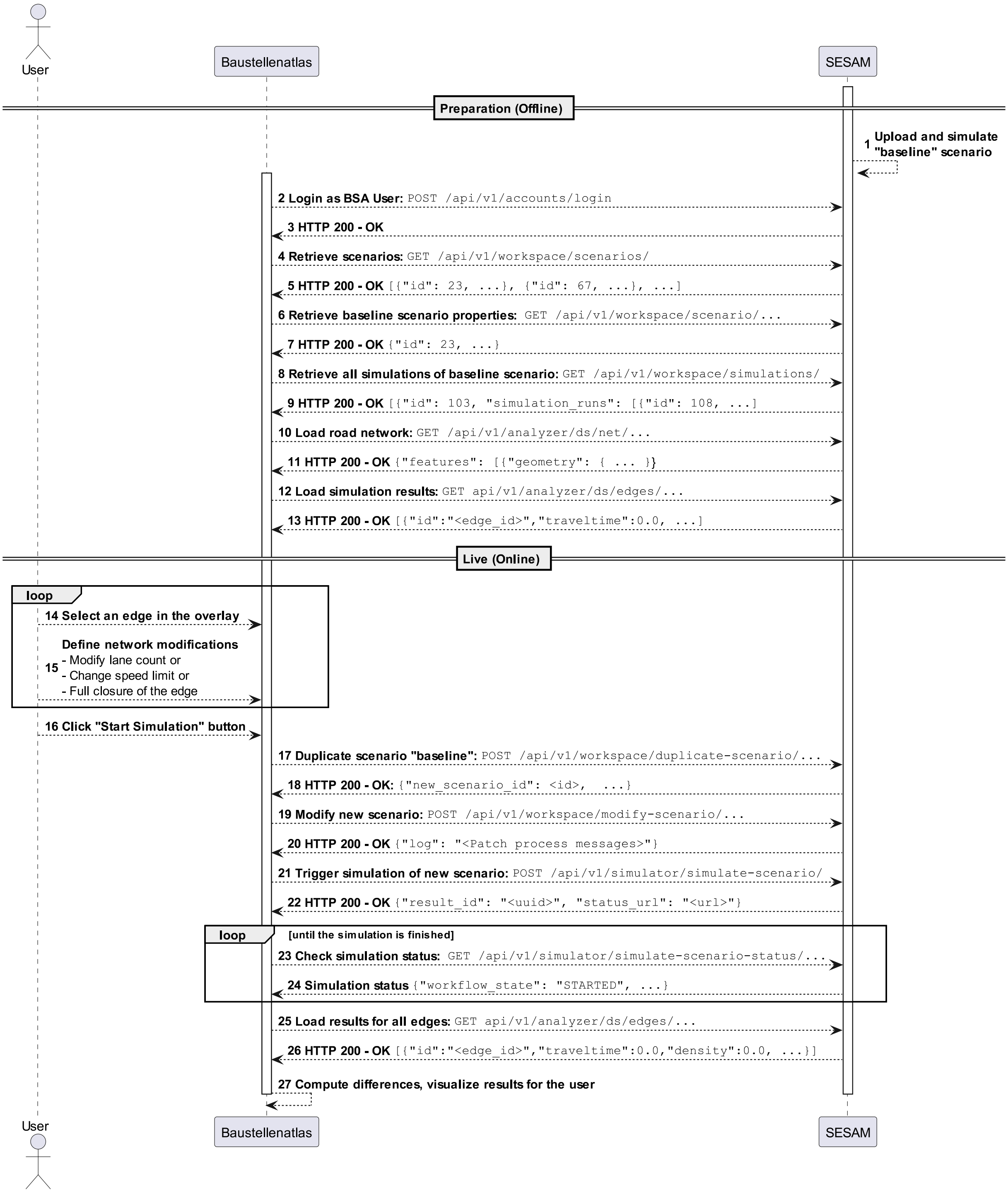

Figure 3. *Description of the REST API Workflow.*

These modifications can be applied to any number of road segments in the scenario network to represent the traffic measures associated with a planned construction site. Once the user has finished editing, the scenario is saved in the *Baustellenatlas*. The scenario network modifications are automatically sent to *SESAM*, where they are processed, and a new traffic simulation for the modified scenario is executed.

The results of the simulation are visualized in Fig. 5. Users can analyze key traffic performance indicators, including vehicle counts per road segment, relative speed compared to the maximum allowed speed and time loss due to congestion. These

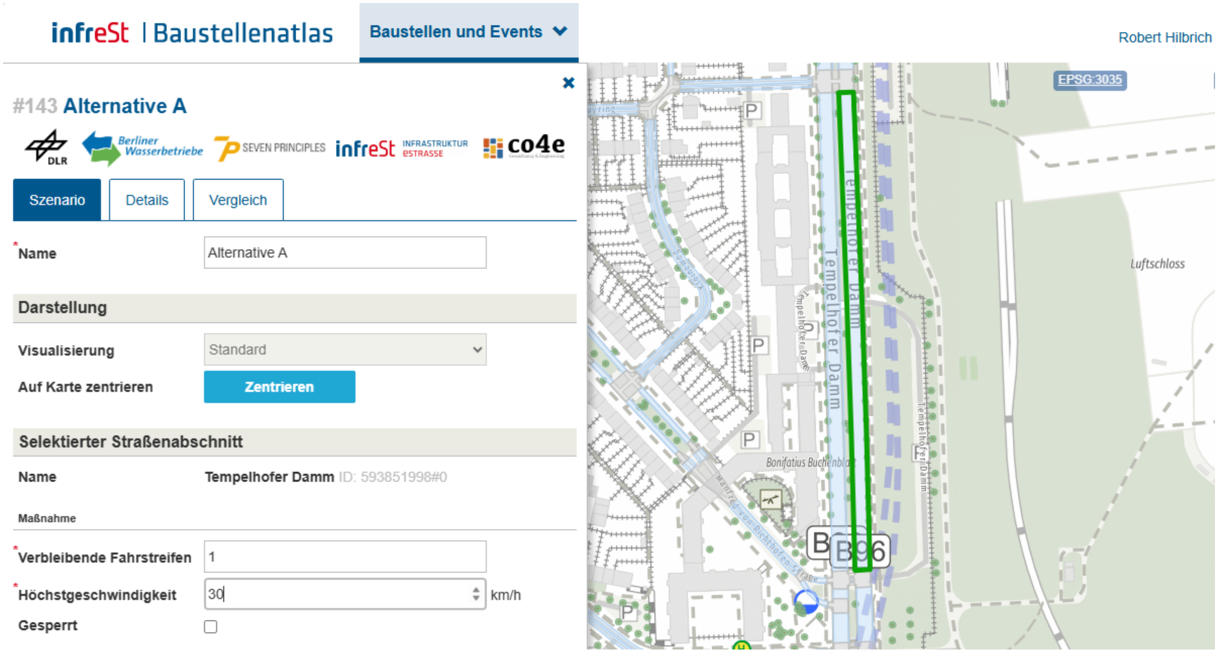

Figure 4. *Modification of a scenario: lane and speed reduction.*

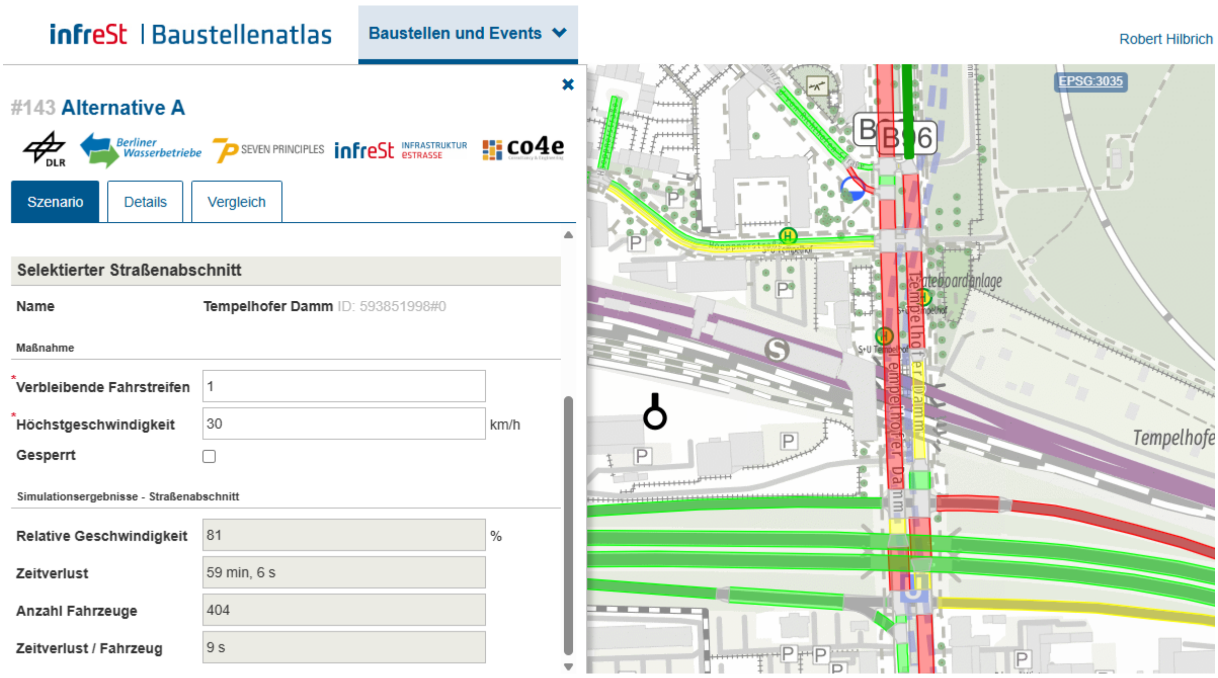

Figure 5. *Reporting of simulation results.*

results are also displayed as an overlay on the map, with road segments color-coded according to the selected metric.

In addition to individual scenario analysis, the *Baustellenatlas* also supports comparisons of different scenarios. Based on the selection of a reference scenario, typically the *baseline scenario*, a comparison with the current (modified) scenario is computed.

As an example in Fig. 6, the comparison highlights differences in absolute vehicle counts on road segments. In this example, as a result of the lane reduction in Fig. 4, fewer vehicles traveled on the modified segment are color coded in green, while more vehicles rerouted through the residential area west of the affected road are indicated

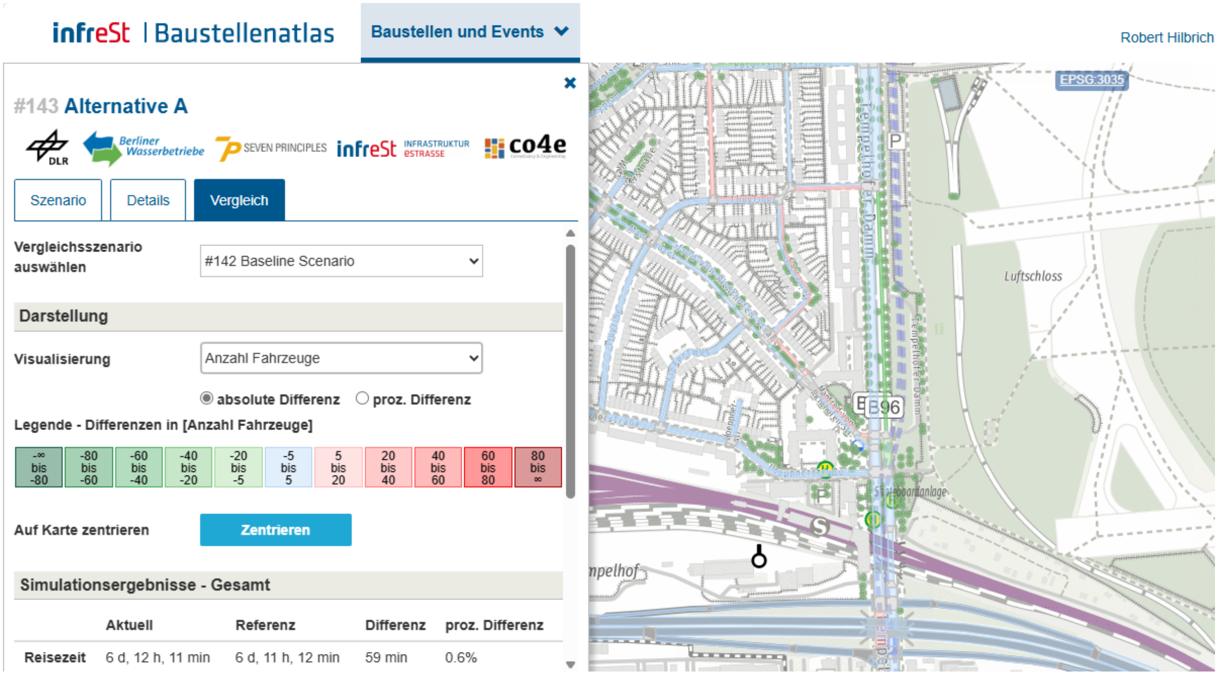

Figure 6. *Comparison of absolute vehicle counts with a baseline scenario.*

with a light red color. Of course, other metrics for comparison, such as relative speed or time loss are supported as well. Moreover, the user can toggle between absolute differences and percentage-based differences to fine tune the analysis.

3. Case Studies

To evaluate the functionality and applicability of the prototype, two different case study scenarios were created. These scenarios were designed to reflect different levels of complexity and provide meaningful insights into how the integration of *Baustellenatlas* and *SESAM* can be utilized for construction site planning.

The first scenario, *Molkenmarkt*, serves as a small-scale demonstration case with randomly generated traffic. This scenario was chosen to provide a fast and simple test case that allows users to quickly observe the system's capabilities. The location was selected based on the headquarters of Berliner Wasserbetriebe, a key project partner.

The second scenario, *Tempelhofer Damm*, is designed to be more realistic and is modeled after an ongoing construction project in Berlin. This scenario incorporates realistic traffic demand and provides a more complex use case to evaluate the system's ability to simulate, analyze, and compare traffic impacts under practical conditions.

The demand in both scenarios only includes motorized individual traffic, meaning only passenger cars were considered. Public transport, trucks, bicycles, and pedestrians were not included in the simulation. This simplification was chosen to focus on the effects of construction sites on general vehicle traffic flow and to keep simulation complexity within manageable limits.

To ensure interactive usability of the prototype, we aimed for a maximum simulation runtime of four minutes. This constraint was set to allow users to quickly modify and test different traffic scenarios without long waiting times. As a result, the complexity and scale of the scenarios had to be adjusted to fit within this performance limit. The following sections introduce these two case studies in detail.

3.1 Molkenmarkt Scenario

The Molkenmarkt scenario represents a typical and manageable urban traffic environment, making it well-suited as a demonstration case for evaluating the prototype. The road network for this scenario was imported from OpenStreetMap (OSM), ensuring that the network structure (almost) accurately reflects real-world conditions. Traffic demand was synthetically generated using SUMO's `randomTrips` tool, which creates randomized trips based on the road network layout. This approach allows for a generic yet dynamic traffic flow while avoiding the complexity of real-world traffic data calibration.

(a) *Road network*

Scenario Property	**Value**
Area size	$7\,518\,939\,\mathrm{m}^2$
Scenario duration	$3600\,\mathrm{s}$
# Edges	983
# Junctions	513
# Traffic lights	35
# Trips (vehicles)	5049
Average route length	$1926.4\,\mathrm{m}$
Average trip speed	$29.2\,\mathrm{km\,h^{-1}}$
Average waiting time	$28\,\mathrm{s}$
Average time loss	$65\,\mathrm{s}$
Average trip duration	$241\,\mathrm{s}$
Simulation runtime	$44\,\mathrm{s}$
# Teleports	0

(b) *Scenario properties and simulation results*

Figure 7. *Key figures for the Molkenmarkt scenario.*

A simulation duration of one hour was chosen to capture a representative traffic flow within the area. However, no dedicated warm-up phase was included, meaning that vehicles start entering an empty network at the beginning of the simulation, which may introduce transient effects in the early minutes.

The relatively short simulation runtime of 44 seconds enabled short iteration cycles during the development and testing of the user interface. This made it possible to efficiently refine the interaction between the *Baustellenatlas* and *SESAM*. Further details and key characteristics of the Molkenmarkt scenario, including network size, vehicle numbers, and performance metrics, are presented in Fig. 7.

3.2 Tempelhofer Damm Scenario

The Tempelhofer Damm scenario was designed to represent a realistic construction site situation for testing the prototype. In contrast to the Molkenmarkt scenario, this scenario is significantly larger and introduces more complexity due to the inclusion of major traffic arteries.

A key characteristic of this scenario is the highway that crosses the area in an east-west direction. This feature explains the comparatively high average speeds observed in the simulation, as a large portion of traffic moves along high-capacity, high-speed routes. The Tempelhofer Damm itself serves as a central north-south corridor, connecting to the highway via an on-ramp and off-ramp system. For the case study, we assume a planned construction site on Tempelhofer Damm, which could result in a full

***(a)** Road network*

Scenario Property	Value
Area size	$77\,174\,239\,\mathrm{m}^2$
Scenario duration	$3600\,\mathrm{s}$
# Edges	2890
# Junctions	1676
# Traffic lights	225
# Trips (vehicles)	$36\,007$
Average route length	$1981.8\,\mathrm{m}$
Average trip speed	$47.9\,\mathrm{km\,h^{-1}}$
Average waiting time	$36\,\mathrm{s}$
Average time loss	$59\,\mathrm{s}$
Average trip duration	$202\,\mathrm{s}$
Simulation runtime	$208\,\mathrm{s}$
# Teleports	0

***(b)** Scenario properties and simulation results*

***Figure 8.** Key figures for the Tempelhofer Damm scenario.*

or partial closure of the road. This scenario provides a realistic test case for evaluating the impact of different construction-related restrictions on urban traffic flow.

Similar to the approach with the Molkenmarkt scenario, the road network was imported from OpenStreetMap (OSM). However, traffic demand was not generated randomly using `randomTrips`. Instead, it was calibrated based on Berlin's daily traffic volume (DTV) statistics [11]. The simulation was set up to model a representative average hour, corresponding to approximately 5% of the daily traffic volume.

As a result of this calibration, vehicles in SUMO were explicitly assigned complete routes for the entire simulation period. The simulation runtime of 208 seconds on *SESAM* is just below our 4-minute limit, making it acceptable for demonstration purposes. Further details and key characteristics of the Tempelhofer Damm scenario are presented in Fig. 8.

The restriction to a maximum runtime of four minutes was indeed a deliberate design decision in the context of the project. It reflects a key requirement for enabling interactive stakeholder collaboration, particularly when using a touch table environment where different actors – such as planners, infrastructure operators, and authorities – jointly explore and discuss construction planning alternatives in real time. While this constraint limits the complexity of scenarios (e.g., the inclusion of multimodal demand or long-term simulations), it was essential to investigate whether the creation and immediate evaluation of alternatives could become part of an interactive planning process. In future iterations, other approaches could be considered – such as simulating alternative scenarios in advance and then presenting their results interactively. However, the goal of this prototype was to assess whether the co-creation of planning variants could itself become an interactive and simulation-supported process. The 4-minute limit was therefore introduced as a pragmatic threshold to enable such real-time feedback during collaborative sessions.

The creation of this scenario and especially its calibration was carried out by our project partner *Seven Principles Mobility GmbH*, using their *MobilityOps* tool [12]. The scenario was then made available to us for use within *SESAM*.

In *MobilityOps* the trip generation from traffic volumes was performed using SUMO's `routeSampler` tool. This tool creates a set of plausible routes based on the network topology and then samples origin-destination pairs in such a way that the resulting flows on the edges approximate the provided traffic volume data (DTV statistics). While this approach ensures a reasonable match with observed traffic volumes at the network level, it does not rely on a population-based or behaviorally grounded modeling of trip purposes or OD distributions. As a result, origins and destinations were *estimated* rather than systematically derived from land use or mobility surveys, which limits the interpretation of rerouting behavior in certain situations.

Furthermore, a systematic validation of the scenario was not conducted, primarily due to time constraints. While the edge-level traffic volumes from the simulation were compared with the input DTV data to ensure plausibility, a detailed validation—such as comparing simulated travel times, turning counts, or route choices with observed measurements was not performed. Instead, the focus of the prototype was on demonstrating the feasibility and usability of integrating traffic simulation into construction planning tools rather than delivering a fully validated traffic model.

4. Lessons Learned

The prototype successfully demonstrated that microscopic traffic simulations can be seamlessly integrated into tools like the *Baustellenatlas*. Users who were previously only familiar with traffic simulation as an expert-driven tool requiring months of preparation were now able to conduct their own analyses and immediately visualize the effects of planned construction sites on traffic flow. This represents a significant step toward making an established tool such as traffic simulations accessible to a broader user base.

However, the interpretation of the simulation results also revealed some initial weaknesses of the approach. Since the results were computed on microscopic-level, it was difficult to analyze and understand on a more coarse grained level how traffic was redistributed due to construction site restrictions. An increase in the number of vehicles on a specific road segment serves as an indicator of rerouting, but for a deeper understanding, it is necessary to visualize aggregated traffic flows, including their origins and destinations. This capability was missing in our current prototype, affecting the ability to conduct detailed rerouting analysis in the *Baustellenatlas*.

A key issue became evident when investigating route modifications caused by road closures. When a road was closed, *SESAM* used SUMO's `duarouter` to repair the affected routes. However, this resulted in very localized rerouting, meaning that vehicles took the shortest possible detour around the closed section. Test users considered this behavior unrealistic, as it more accurately reflects a spontaneous detour after a sudden incident (e.g., an accident or emergency roadblock) rather than the longer-term impact of planned construction projects. The focus of our prototype, however, was on the 2–6 weeks following a planned construction measure, during which drivers would have adjusted their route choices based on prior knowledge of the roadwork's impact on travel times. This limitation was directly related to the calibrated demand model in the Tempelhofer Damm scenario, which relied on predefined fixed routes for all vehicles. While this ensured consistency with real-world traffic volumes, it also prevented large-scale rerouting when a construction site affected major roads. To address this, we modified the Tempelhofer Damm scenario to use trip-based vehicle generation instead of predefined routes, meaning that only the start and destination of each trip were fixed, while

SUMO dynamically computed routes at runtime. This change resulted in the expected redistribution of traffic, with a more realistic large-scale detour behavior, but at the cost of losing the detailed route calibration based on real-world data.

Beyond the limitations discussed above, several additional effects lie outside the scope of this prototype. These include mode shift (e.g., switching to public transport or active modes due to construction-related disruptions) and traffic evaporation, i.e., the disappearance of trips when congestion makes them unattractive. Capturing such behavioral adaptations would require longer simulation horizons and multimodal demand modeling. Incorporating these effects would significantly increase the computational complexity of the simulations and require more elaborate behavioral models. This, in turn, would compromise the lightweight and interactive usability that our prototype is designed for—especially in stakeholder workshops or real-time planning sessions. Instead, we focused deliberately on short-term impacts and rerouting effects within a fixed demand, as these aspects are most relevant for the operational coordination of construction sites today.

Testing the prototype also revealed several overlooked aspects in the initial simulation setup. For example, no warm-up phase was included at first, meaning that at the beginning of the simulation, vehicles entered an empty network. This led to unrealistic traffic conditions during the initial minutes. In a later iteration, *SESAM* was extended to support a warm-up phase, where traffic was simulated for 15 minutes before data collection started.

Following best practices for traffic simulation [13], it is generally recommended to run multiple simulation iterations with different random seeds to account for stochastic variations in traffic flow. *SESAM* inherently supports this functionality, allowing parallel execution of simulations with different seeds on separate CPU cores to minimize runtime overhead. However, in the current prototype, we focused on single-run simulations for simplicity. While SESAM already provides the capability to perform multiple randomized runs efficiently, we are still in the process of developing a standardized data exchange format and interface to transmit the resulting statistical spread to the *Baustellenatlas* and to visualize it appropriately in the frontend. This extension will allow users to assess not only average effects but also the robustness and variability of traffic impact assessments under different random conditions.

Another challenge emerged in the ability to modify traffic networks within the prototype. While lane closures, speed reductions, and full road closures were supported, adjustments to lane-to-lane connections at intersections were not possible. In real-world scenarios, such modifications would be necessary to reflect temporary changes due to construction. Similarly, modifications to traffic signal plans were not implemented, limiting the ability to explore mitigation strategies such as adjusting green times to better accommodate detoured traffic.

A mesoscopic modeling approach might help mitigate some of the effects resulting from unrealistic or unknown traffic signal settings. However, in our case, many of the traffic management measures under discussion – such as lane closures – require microscopic modeling to realistically capture the interactions between individual vehicles and their response to constrained road geometries. Therefore, while a mesoscopic approach could be beneficial in broader strategic assessments or when signal plans are uncertain, a microscopic simulation was necessary for the detailed representation of local effects at and near the construction site.

A further limitation was the lack of explicit rerouting control. *SUMO* allows for the definition of recommended detour routes with compliance rates, which can simulate how strictly drivers adhere to designated detour routes. This functionality was not included in the prototype, meaning that all rerouting was purely demand-driven. Incorporating this feature would improve the ability to simulate realistic rerouting strategies in response to planned roadworks.

Finally, discussions with users revealed that assessing the acceptability of traffic impacts caused by a construction site still remains challenging with the current prototype. While the simulation provides detailed microscopic-level results, it is still unclear which thresholds should be applied to determine whether a construction measure is acceptable or requires further mitigation. One possible approach could be to use macroscopic performance indicators, such as the Quality Levels of Traffic Flow (*Qualitätsstufen des Verkehrsablaufs - QSV*) from the German *Handbuch für die Bemessung von Straßenverkehrsanlagen (HBS)* [14], instead of relying solely on microscopic vehicle counts and travel times. These QSV levels are conceptually similar to the Level of Service (LOS) classes A to F described in the U.S. Highway Capacity Manual (HCM), which are commonly used to characterize traffic conditions in terms of delay and performance, particularly at intersections [15]. Visualizing changes in QSV levels could make the results more interpretable and provide a stronger basis for decision-making in construction site planning. Currently, this aspect remains an open issue and could be a key focus of future improvements to the system.

Despite these challenges, the prototype still provided a valuable proof of concept for integrating microscopic simulation into construction site planning. The ability to directly interact with a traffic simulation via an intuitive frontend significantly lowers the barrier for using simulation-based impact assessments. However, further refinements are necessary to improve visualization, enhance rerouting behavior, and expand network modification options to increase the realism of simulated scenarios.

5. Conclusion and Future Work

This paper presents a prototype that integrates microscopic traffic simulation into construction site coordination, enabling data-driven impact assessments for planned roadworks. By linking the *Baustellenatlas* with *SESAM* the system allows users with limited background in traffic simulations to define, modify, and analyze construction scenarios in a seamless workflow. The prototype was evaluated in two case studies in Berlin. The Molkenmarkt scenario served as a small-scale demonstrator with randomized traffic, allowing for rapid iterations during development. The Tempelhofer Damm scenario, in contrast, was designed to reflect a realistic construction site situation, incorporating calibrated demand data based on Berlin's daily traffic volumes. The analysis of these scenarios demonstrated that integrating traffic simulations into early-stage construction planning helps visualize and quantify expected traffic shifts, providing planners with relevant insights.

However, several challenges remain. Microscopic simulation results offer high detail but make it difficult to aggregate and interpret large-scale rerouting effects. The handling of long-term detour behavior needs to be improved, as initial simulations focused on short-term rerouting responses. Additionally, network modification capabilities in the prototype are currently limited, as intersection adjustments and traffic signal plan modifications are not yet supported.

In the next development phase, we aim to enable modifications of lane-to-lane connections and traffic signal plans to enhance the flexibility and realism of modified scenarios. Furthermore, we plan to investigate how daily traffic volumes for Berlin can be *automatically* extracted and used for scenario calibration. Realistic demand modeling is crucial for ensuring the reliability of simulation results and providing meaningful assessments.

Beyond technical advancements, we also intend to engage with key stakeholders to introduce this prototype and discuss its impact on existing planning workflows. Understanding the practical integration of simulation-based assessments into real-world decision-making processes will help refine the tool's usability and effectiveness. Another promising avenue for future development is the integration of environmental impact assessments, such as emission modeling for noise and air pollutants. Including these factors would expand the scope of the prototype beyond traffic flow analysis and provide a holistic assessment of construction-related externalities.

Author Contributions

Robert Hilbrich: Conceptualization, Methodology, Software, Writing – Original Draft, Writing – Review & Editing, Visualization.
Jürgen Besler: Conceptualization, Methodology, Writing – Review & Editing.
Natalie Dust: Software, Methodology, Writing – Review & Editing.
Heiner Kretzer: Conceptualization, Methodology, Writing – Review & Editing.
Bertram Monninkhoff: Software, Conceptualization, Methodology, Writing – Review & Editing.

Competing Interests

The authors declare that they have no competing interests.

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References

[1] P. Alvarez Lopez et al., "Microscopic Traffic Simulation using SUMO," in *2019 IEEE Intelligent Transportation Systems Conference (ITSC)*, IEEE, Nov. 2018, pp. 2575–2582. [Online]. Available: https://elib.dlr.de/127994/.

[2] E. Fernandez, S. Lobo, and S. Neumeier, "Intas–the Ingolstadt Traffic Scenario for SUMO," *arXiv preprint arXiv:2011.11995*, 2020. [Online]. Available: https://arxiv.org/abs/2011.11995.

[3] P. Ribeiro, "A Modelling Methodology Towards Automated Generation of Road Network Digital Twins," *University of Porto Repository*, 2023. [Online]. Available: https://repositorio-aberto.up.pt/bitstream/10216/153832/2/647753.pdf.

[4] A. Hegde, R. Stahl, S. Lobo, and A. Festag, "Modeling Cellular Network Infrastructure in SUMO," in *SUMO Conference*, 2022. [Online]. Available: https://opus4.kobv.de/opus4-haw/files/1478/Conference_paper_Hedge_A4.pdf.

[5] M. Chowdhury and T. Chakraborty, "Calibration of SUMO Microscopic Simulation for Heterogeneous Traffic Condition: The Case of the City of Khulna, Bangladesh," *ResearchGate*, 2023. [Online]. Available: https://www.researchgate.net/publication/384616945_Calibration_of_SUMO_Microscopic_Simulation_for_Heterogeneous_Traffic_Condition_The_Case_of_the_City_of_Khulna_Bangladesh.

[6] A. R. Marian, R. Hijazi, E. Masad, and A. Abdel-Wahab, "Quantifying the vulnerability of road networks to flood-induced closures using traffic simulation," *Transportation Research Record*, vol. 2678, no. 4, pp. 1–15, 2024. DOI: 10.1177/03611981241234567. [Online]. Available: https://www.researchgate.net/profile/Rakan-Hijazi/publication/382633648_Quantifying_the_Vulnerability_of_Road_Networks_to_Flood-Induced_Closures_Using_Traffic_Simulation/links/66b9e32451aa0775f27a9cc1/Quantifying-the-Vulnerability-of-Road-Networks-to-Flood-Induced-Closures-Using-Traffic-Simulation.pdf.

[7] M. Abbasi, M. T. Bilal, A. Consilvio, and D. Giglio, "On minimizing the impact on traffic of maintenance work zones in a highway network," *Journal of Transportation Engineering*, vol. 150, no. 3, pp. 1–10, 2024. DOI: 10.1016/j.jtreng.2024.103456. [Online]. Available: https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=5096244.

[8] co4e GmbH. "SESAM: Mobility Simulations in the Cloud," Accessed: Mar. 11, 2025. [Online]. Available: https://sesam.co4e.com/.

[9] co4e GmbH. "SESAM Documentation - API Guide," Accessed: Mar. 11, 2025. [Online]. Available: https://sesam.co4e.com/docs/api/.

[10] Infrastruktur eStrasse GmbH. "Infrest Baustellenatlas Produktportfolio," Accessed: Mar. 11, 2025. [Online]. Available: https://www.infrest.de/produktportfolio/infrest-baustellenatlas/.

[11] Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen. "Geoportal Berlin - Verkehrsmengen DTVw 2019," Accessed: Mar. 13, 2025. [Online]. Available: https://gdi.berlin.de/viewer/main/?Map/layerIds=hintergrund_default_grau,verkehrsmengen_2019:dtvw2019kfz.

[12] Seven Principles Mobility GmbH. "strazoon MobilityOps," Accessed: Mar. 13, 2025. [Online]. Available: https://strazoon.com/planning-solutions/.

[13] Federal Highway Administration (FHWA), "Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software," U.S. Department of Transportation, Federal Highway Administration, Tech. Rep. FHWA-HOP-18-036, 2018, Beinhaltet Richtlinien zur Anwendung mikroskopischer Verkehrssimulationssoftware, einschließlich Modellkalibrierung, Validierung und Analyseprozessen. [Online]. Available: https://ops.fhwa.dot.gov/publications/fhwahop18036/index.htm.

[14] Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV), "Handbuch für die Bemessung von Straßenverkehrsanlagen (HBS)," in 3. Auflage, Behandelt unter anderem die Qualitätsstufen des Verkehrsablaufs (QSV) für Stadtstraßen., Köln, Deutschland: FGSV Verlag, 2015, ch. Teil S: Stadtstraßen.

[15] Transportation Research Board, *Highway Capacity Manual, Sixth Edition: A Guide for Multimodal Mobility Analysis*. Washington, D.C.: National Academy of Sciences, 2016, Transportation Research Board, National Research Council, ISBN: 978-0-309-26148-3. [Online]. Available: https://www.trb.org/Main/Blurbs/175169.aspx.