An agent-based impact evaluation of the speed limit reduction on the Paris Ring Road

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1 Introduction

Among the various restrictive measures aimed at reducing private car usage, lowering speed limits has emerged as a widely adopted strategy by mobility and transportation authorities Jang et al. (2022). The city of Paris recently reduced the speed limit on its ring road (*Bd Périphérique*) from 70 km/h to 50 km/h. This policy is expected to induce notable behavioral changes among drivers, such as route modifications and potential shifts to car-alternative modes. To fully understand the impact of this measure, it is crucial to conduct an ex-post evaluation, offering a detailed spatial analysis of these behavioral changes. Furthermore, an ex-ante assessment incorporating these adaptations is essential for forecasting the measure's broader effects under varying traffic conditions.
Agent-based simulations are practical tools for evaluating the effects of speed limit reductions on urban transport systems. Multi-agent models, such as *MATSim* Horni et al. (2016), allow for a detailed exploration of policy impacts across different population segments and temporal contexts He et al. (2021); Zargiannaki et al. (2022). These models can capture complex interactions between speed limit changes, mode shifts, and travel patterns Zargiannaki et al. (2022). These simulations can also assess effects on road safety, traffic efficiency, and environmental factors at various spatial levels Lu et al. (2023).
The objectives of this work are twofold. First, we conduct a preliminary assessment of the impact of the reduction of the speed limit on the Parisian ring road by analyzing in greater detail the behavioral changes (particularly traffic redistribution and modal shift) and their consequences on congestion levels using *MATSim* and its integrated mode choice behavioral model. The second objective lies in analyzing the advantages and limitations of agent-based simulation in the impact evaluation of such traffic regulation measures.

2 Methodology

Simulation environment

This study employs the Multi-Agent Transport Simulation framework, *MATSim* Horni et al. (2016), coupled with the discrete mode choice (DMC) module Hörl et al. (2019). Travel demand is represented through a synthetic population, where each agent is characterized by socio-demographic attributes and a set of daily activity plans (e.g., home, work, education, leisure) and corresponding trips.
The synthetic population (5% of the actual population) and the supply networks are generated using the *EQASIM* pipeline, previously utilized for the open Île-de-France *MATSim* scenario Hörl & Balać (2021), referred to here as the 70 km/h baseline scenario. Subsequently, the road network, specifically the segments corresponding to the Paris ring road, has been modified to reflect the reduced speed limit, thereby defining the 50 km/h scenario.

Case study

The city of Paris, denoted by department code 75 in Figure 1, is the central city of the Île-de-France (IdF) region. It is the most densely populated department, followed by the inner-ring departments departments (92, 93, and 94). The outer ring, comprising departments 77, 78, 91, and 95, includes more suburban areas. A highly developed transport network

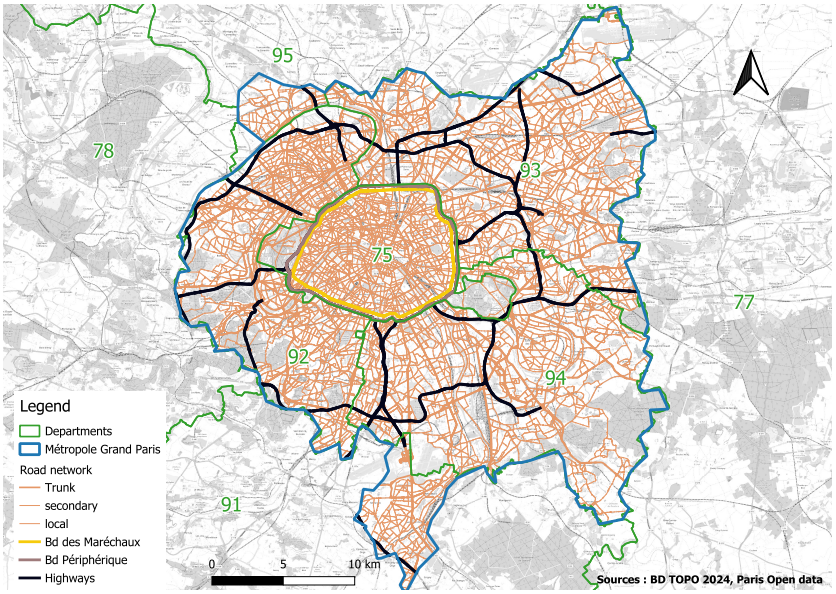

Figure 1: Paris' Boulevard Périphérique (ring road), the Boulevards des Maréchaux, and the main roadways connecting the city to neighboring departments.

structure supports this strongly monocentric urbanization model. The highway system exhibits a star-shaped configuration, with radial connections linking the urban center to the peripheral areas (Figure 1).

3 Results

	All IdF			Paris O or D			Paris without internal		
	Car	PT	Bike	Car	PT	Bike	Car	PT	Bike
Travel Survey (*EGT*)	30.7	20.6	1.6	12.8	42	2.3	24.1	68.1	1
70 km/h scena.	31.3	20.5	1.3	12.2	41.7	2	24.1	65.3	0.5
50 km/h scena.	31.3	20.5	1.3	12.3	41.6	2	24.2	65.3	0.5
Variation (%)	**0**	**0**	**0**	**+0.8**	**-0.2**	**0**	**+0.5**	**0**	**0**

Table 1: Comparison of modal share according to different trips origin/destination (O/D).

Table 1 reports the modal shares estimates from both the travel survey and simulations for car, public transport (PT), and bike across three spatial scopes: all trips within the Île-de-France region (All IdF), trips with either an origin or a destination in Paris (Paris O or D), and trips connecting Paris to surrounding areas, excluding intra-Paris travel (Paris without internal). Overall, the results indicate no substantial modal shift following the implementation of the speed limit reduction. Nonetheless, a slight increase in car usage is observed for trips involving Paris, suggesting a marginal reallocation of mode choice in favor of private vehicles.

Simulation results indicate a notable reduction in traffic volumes on the ring road following

the implementation of the 50 km/h speed limit, accompanied by increased flows on major alternative routes, particularly the *A*86 highway and the *boulevards des Maréchaux*. Specifically, the simulation suggests an average relative increase of approximately 12% and 6% on the inner (*boulevards des Maréchaux*) and outer (*A*86) alternatives, respectively, alongside an average 20% decline in flows on the ring road itself. This trend is corroborated by observed traffic counts across the analyzed periods. *MATSim* effectively reproduces the typical bimodal ("camel humps") shape of daily traffic flow, corresponding to the morning and evening commuter peaks. The lower traffic volumes observed in the simulation, compared to the actual counts, can be attributed to the synthetic demand's exclusion of business, transit, and logistics trips. Nonetheless, *MATSim* aligns well with observed spatial redistribution patterns, particularly the shift of a portion of traffic from the ring road toward alternative inner routes.

Regarding the speed profiles on the ring road, *MATSim* simulates an average speed of 44.7 km/h for the 50 km/h scenario and 58.2 km/h for baseline 70 km/h scenario. While *MATSim* reproduces the temporal dynamics of congestion, particularly the morning (7–9 a.m.) and evening (5–7 p.m.) peak periods, the simulated average speeds are higher than measurements values. According to measurements, average speeds were 36.1 km/h in November 2024 (after implementation of the reduced speed limit) and 37 km/h in November 2023. This discrepancy may be partially explained by the simulation's exclusion of freight, logistics, and transit-related flows, which typically contribute to lower average speeds. Additionally, limitations in *MATSim*'s traffic flow model, particularly the absence of detailed vehicle-following dynamics in its queue-based traffic representation, may prevent accurate reproduction of real-world congestion buildup and dissipation.

Finally, measurements data suggest that the reduction in speed limit to 50 km/h had no substantial effect on peak-hour travel dynamics. Lower speed limits may lead to more homogeneous traffic flow and higher median speeds, whereas higher limits such as 70 km/h tend to amplify stop-and-go patterns under congested conditions. This observation supports findings in the literature suggesting that reduced speed limits can indirectly enhance traffic stability and flow efficiency during high-density periods Jang et al. (2022).

References

He, B. Y., Zhou, J., Ma, Z., Wang, D., Sha, D., Lee, M., & Chow, J. Y. J. (2021). A validated multi-agent simulation test bed to evaluate congestion pricing policies on population segments by time-of-day in New York City. *Transport Policy*, *101*(December 2020), 145–161. Retrieved from `https://doi.org/10.1016/j.tranpol.2020.12.011` doi: 10.1016/j.tranpol.2020.12.011

Hörl, S., Balać, M., & Axhausen, K. W. (2019). Pairing discrete mode choice models and agent-based transport simulation with matsim. In *Trb annual meeting*.

Horni, A., Nagel, K., & Axhausen, K. (2016). *Multi-agent transport simulation matsim*. London: Ubiquity Press. doi: 10.5334/baw

Hörl, S., & Balać, M. (2021). Synthetic population and travel demand for paris and Île-de-france based on open and publicly available data. *Transportation Research Part C: Emerging Technologies*, *130*, 103291. doi: doi.org/10.1016/j.trc.2021.103291

Jang, S., Wu, S., Kim, D., Song, K.-h., Lee, S. M., & Suh, W. (2022). Impact of Lowering Speed Limit on Urban Transportation Network. *Applied Sciences*.

Lu, Q.-l., Qurashi, M., & Antoniou, C. (2023). Simulation-based policy analysis : The case of urban speed limits. *Transportation Research Part A*, *175*(July), 103754. Retrieved from `https://doi.org/10.1016/j.tra.2023.103754` doi: 10.1016/j.tra.2023.103754

Zargiannaki, E., Tzouras, P. G., Antoniou, E., Karolemeas, C., & Kepaptsoglou, K. (2022). Assessing the impacts of traffic calming at network level : A multimodal agent-based simulation. *Journal of Traffic and Transportation Engineering (English Edition)*, *11*(1), 41–54. Retrieved from `https://doi.org/10.1016/j.jtte.2023.01.003` doi: 10.1016/j.jtte.2023.01.003