Driverless vehicles may lead to traffic congestion in cities

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Introducing self-driving taxis would also have far-reaching consequences for the city's public transport. Credit: pxhere.com / CC0 1.0

A unique simulation for the city of Zurich shows that driverless taxis would not displace personal transport in cities as long as automated private vehicles are also available. Previous simulations assumed too high a demand for automated taxi services, as they did not take into account user preferences regarding flexibility, costs and waiting times.

Current trends such as digitalisation and the sharing economy will fundamentally change mobility in cities—on this most experts agree. In the future, public transport will be electric, customised, and readily available via smartphone. The first driverless taxi services have already been launched in Las Vegas and Phoenix in a bid to create a mobility system with significantly fewer vehicles, lower emissions, and at a lower cost (88 percent of the cost of a taxi ride in Zurich today pays for the driver). Previous studies encouraged these hopes: in 2014, researchers studying Singapore concluded that, with automated taxis, total demand for mobility could be met with just a third of the current vehicle fleet. In a study for Austin, the capital of the US state of Texas, researchers predicted that the fleet could be reduced by as much as 90 percent. Based on such studies, ridesharing companies such as Uber and Lyft sensed a huge market for their services, which will dispense with drivers in the future.

Simulations with broader scope

Kay Axhausen, Professor at ETH Zurich's Institute for Transport Planning and Systems, has now come to new conclusions in a study conducted on behalf of the Swiss Association of Transport Engineers and Experts (SVI) and financed by Switzerland's Federal Roads Office (FEDRO). His team simulated how Zurich's traffic volume might change if automated taxis were to be introduced at some point over the next two decades. The result was surprising: offering a ridesharing service would not decrease the number of private vehicles, and automated transport might even increase the number of kilometres driven.

In this form, the study is one of a kind in the world, as Axhausen explains: "Previous simulations mostly assumed ideal conditions, such as that every road user opts for an automated taxi provided waiting times are below a certain level." By contrast, his team developed a simulation that takes into account supply and demand as well as users' individual

behaviour patterns. For a given fleet size, this generates a certain price per ride and a certain level of demand.

The researchers used MATSim, a simulation platform that ETH and TU Berlin have been refining for more than ten years, which has established itself as a tool for simulating complex mobility questions. MATSim is agent-based, which means it is driven by the behaviour of virtual road users with individual decision-making patterns, and not by overarching rules. To ensure that the behaviour of these agents was as realistic as possible for the study, Axhausen's team conducted a survey in the canton of Zurich. They asked 359 people to name the conditions under which they would be willing to switch to automated, shared transport, with particular attention to how this depended on waiting time and price.

3,000 automated taxis is the sweet spot

For the initial scenario, the existing transport system was supplemented with a fleet of self-driving taxis. In a simulation with some 150,000 agents representing 10 percent of Zurich road users, "automated public transport—including self-driving buses, rail and taxis—achieved more than 60 percent of total transport. At the same time, the share of motorised personal transport sank from 44 to 29 percent. Axhausen's team experimented with various fleet sizes. "If the fleet is too small, the service is not attractive to users," Axhausen explains, "but if it's too large, the service becomes too expensive and similarly unattractive." The ideal level of demand and price lies at a fleet of some 3,000 automated taxis, which results in a price of 56 rappen (about half of 1 euro) per kilometre driven. This roughly corresponds to the current per kilometre costs of a conventional private vehicle, but is much lower than the 2.73 Swiss francs per kilometre of a conventional taxi.

For the second scenario, survey participants were given the option of buying their own automated vehicle instead of sharing one with other

users. While the number of passenger cars per household declined substantially in the first scenario, the overall number of cars was more or less unchanged in the second scenario. "The combination of high flexibility and the chance to make good use of time spent in the vehicle makes this form of mobility very attractive—especially when all family members can use the vehicle," Axhausen says. In the simulation, private driverless cars appear so attractive that they even increase volume on the roads: Axhausen's virtual agents travelled up to 250,000 additional kilometres per day in automated private vehicles. For this reason, the authors urge the authorities to regulate the introduction of self-driving cars.

Competition and opportunity for public transport

Introducing self-driving taxis would also have far-reaching consequences for the city's public transport. In some respects, automation would benefit public transport; automating buses, for example, would halve the cost of a bus ride, according to the study. Even in the face of falling costs for shared taxi rides, buses would remain attractive. On the other hand, the second scenario indicates that the strong appeal of private automated vehicles could lure users away from public transport.

Based on the latest findings, Axhausen believes a reevaluation of automated urban transport is necessary. "Automated taxi fleets will initially remain relatively small due to costs alone," he says, "and the assumption that personal transport will give way to shared automated vehicles is incorrect." For this reason, Axhausen also doubts whether just a few ridesharing companies will meet all urban traffic needs in the future. This contrasts with Uber or Lyft, whose confident projections—based on older simulations—assume that their services will soon attain a monopoly.

More information: Kay Axhausen. Urban road network performance

with shared automated vehicles, *Transportation Research Board*. 2019. www.research-collection.ethz.c … /20.500.11850/293708

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