Impact of competition between autonomous vehicles and public transit

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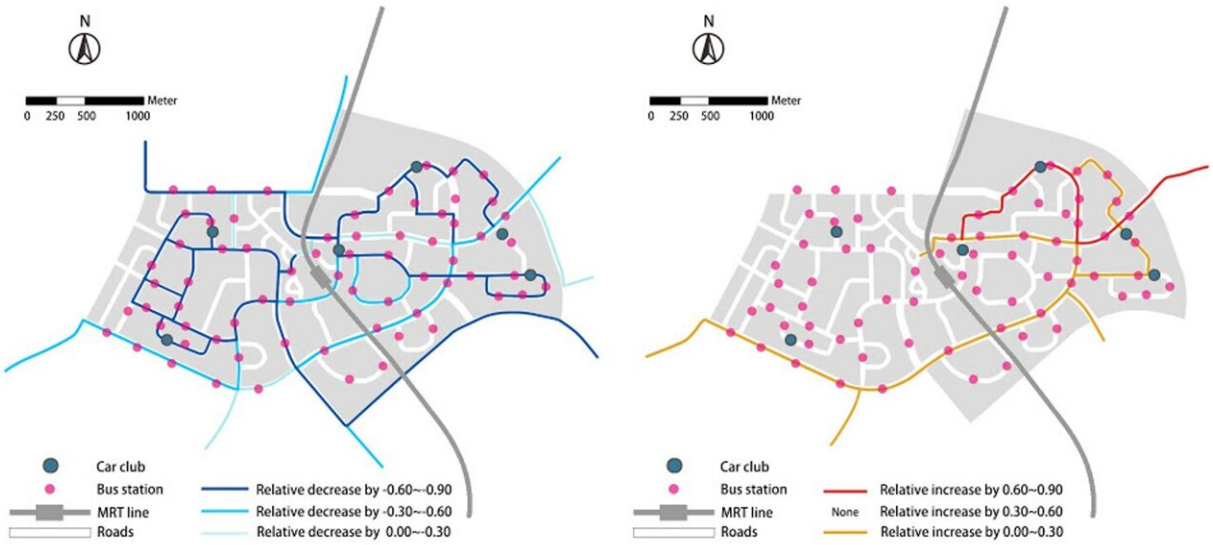


Spatial distribution changes in PT supply during the competition: (left) Routes with supply decrease; (right) Routes with supply increase. Credit: Zhejing Cao and Baichuan Mo

The rapid advancement of autonomous vehicles (AV) technology in recent years has changed transport systems and consumer habits globally. As countries worldwide see a surge in AV usage, the rise of shared autonomous mobility on demand (AMoD) service likely forthcoming. Public transit (PT), a critical component of urban transportation, will inevitably be impacted by the upcoming influx of AMoD, raising the

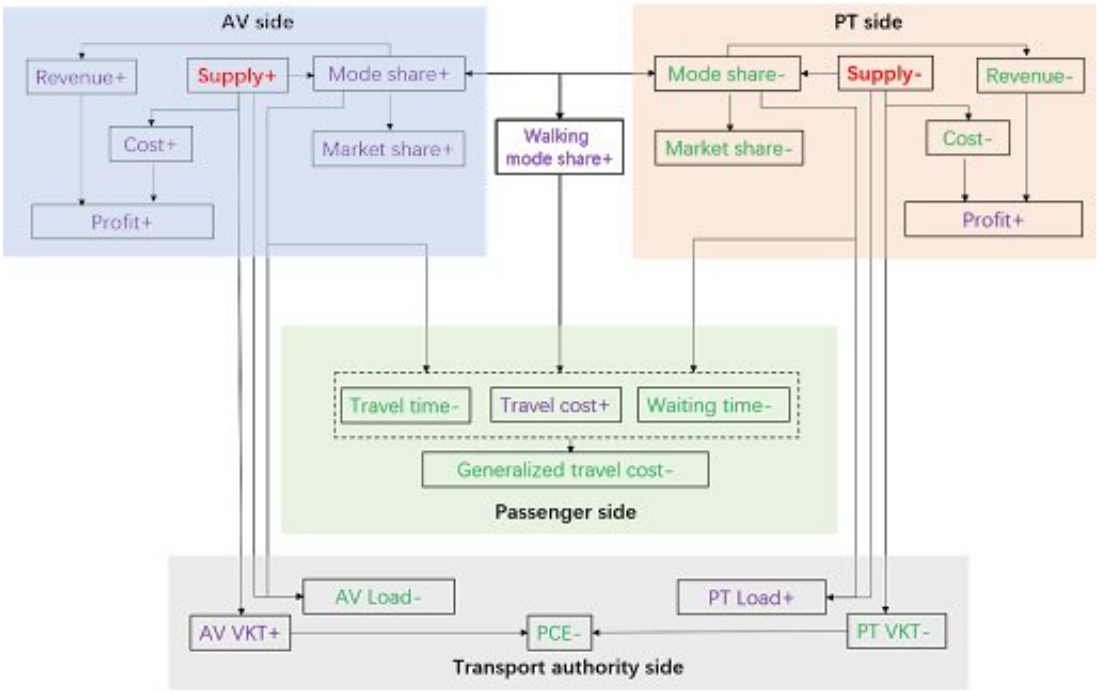
question of whether AMoD would co-exist with or threaten the PT system.

Researchers at the Future Urban Mobility (FM) Interdisciplinary Research Group (IRG) at Singapore–MIT Alliance for Research and Technology (SMART), MIT's research enterprise in Singapore, and Massachusetts Institute of Technology (MIT), conducted a case study in the first-mile mobility market from origins to subway stations in Tampines, Singapore, to find out.

In a paper titled "Competition between Shared Autonomous Vehicles and Public Transit: A Case Study in Singapore," recently published in *Transportation Research Part C: Emerging Technologies*, the first-of-its-kind study used game theory to analyze the competition between AMoD and PT.

The study was simulated and evaluated from a competitive perspective—where both AMoD and PT operators are profit-oriented with dynamically adjustable supply strategies. Using an agent-based simulation, the competition process and system performance were evaluated from the standpoints of four stakeholders—the AMoD operator, the PT operator, passengers and the transport authority.

"The objective of our study is to envision cities of the future and to understand how competition between AMoD and PT will impact the evolution of transportation systems," says Associate Professor Jinhua Zhao. "Our study found that competition between AMoD and PT can be favourable, leading to increased profits and system efficiency for both operators when compared to the status quo, while also benefiting the public and the transport authorities. However, the impact of the competition on passengers is uneven, and authorities may be required to provide support for people who suffer from higher travel costs or longer travel times in terms of discounts or other feeder modes."



Impact of the competition between AMoD and PT on different stakeholders compared to the status quo scenario. The increase (purple) and decrease (green) of different indicators are shown by "+" and "–" respectively. Credit: Zhejing Cao and Baichuan Mo

The research found that the competition between AMoD and PT would compel bus operators to reduce the frequency of inefficient routes and allow AMoDs to fill in the gaps in the service coverage. "Although the overall bus supply was reduced, the change was not uniform," says the first author of the paper, a Ph.D. candidate at MIT, Baichuan Mo. "We found that PT services will be spatially concentrated to shorter routes that feed directly to the subway station, and temporally concentrated to peak hours. On average, this reduces travel time of passengers but increases travel costs. However, the generalised travel cost is reduced when incorporating the value of time." The study also found that providing subsidies to PT services would result in a relatively higher

supply, profit, and market share for PT as compared to AMoD, and increased passenger generalised travel cost and total system passenger car equivalent (PCE), which is measured by the average vehicle load and the total vehicle kilometer traveled.

The findings suggest that PT should be allowed to optimise its supply strategies under specific operation goals and constraints to improve efficiency. On the other hand, AMoD operations should be regulated to reduce detrimental system impacts, including limiting the number of licenses, operation time and service areas, resulting in AMoD operating in a manner more complementary to PT systems.

"Our research shows that under the right conditions, an AMoD–PT integrated transport system can effectively co-exist and complement each other, benefiting all four stakeholders involved," says SMART FM alumni, Hongmou Zhang, a Ph.D. graduate from MIT's Department of Urban Studies and Planning, and now Assistant Professor at Peking University School of Government. "Our findings will help the industry, policy makers and government bodies create future policies and plans to maximise the efficiency and sustainability of transportation systems, as well as protect the social welfare of residents as passengers."

The findings of this study are important for future mobility industries and relevant government bodies, providing insight into the possible evolution and threats to urban transportation systems with the rise of AV and AMoD, and offers a predictive guide for future policy and regulation designs for a AMoD–PT integrated transport system. Policymakers should consider the uneven social costs, such as increased travel costs or travel time, especially to vulnerable groups, by supporting and providing them with discounts or other feeder modes.

More information: Baichuan Mo et al. Competition between shared autonomous vehicles and public transit: A case study in Singapore,

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