On-demand pooling in Christchurch: benefit or bane?

New Zealand cities tend to be low-density, and public transportation may not be easily accessible in some areas. On-demand pooled-ride services can offer convenient transportation solutions, either through direct door-to-door trips or as first- and last-mile connections to public transportation networks. However, as the market for on-demand transportation expands, it is important to consider the impacts of on-demand vehicles on network performance and sustainability. This study employs agent-based mesoscopic simulation to explore the potential effects of a large-scale on-demand pooled-ride service operating in Christchurch's Central Business District (CBD) during the morning peak period. The network, modelled in Aimsun Next, covers an area of approximately 6.3 square kilometres, comprising around 1,550 links and 490 nodes. It contains 102 signalised intersections, with signal timings configured as fixed cycles based on observations of the Sydney Coordinated Adaptive Traffic System (SCATS) in Christchurch. Bus routes, stops, and timetables are set using realistic data from Metro, Christchurch's public bus service provider. Car traffic demand is generated using 199 × 203 origin-destination pairs based on real data sourced from the Christchurch Assignment and Simulation Traffic (CAST) model maintained by the Christchurch City Council. The on-demand service is modelled using a modified insertion algorithm that prioritises user experience while maintaining computational efficiency. Fleet sizes ranging from 2,500 to 12,500 vehicles were tested with a demand of 11,032 requests (representing a 25% modal shift from private vehicles). Analysis using Network Macroscopic Fundamental Diagrams (NMFDs) revealed that the on-demand service increased effective network capacity by approximately 20% and maintained steady network flow as vehicle accumulation increased, while the network without the on-demand service experienced reduced flow due to congestion. This suggests that large on-demand pooled-ride services may stabilise traffic flow patterns and increase the effective capacity of the network, potentially decreasing congestion during peak periods.