National Center for Sustainable Transportation

RESEARCH BRIEF

Flexible Routing for Ridesharing

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Research Question

Traffic congestion is a significant problem in major metropolitan areas in the United States. According to the Urban Mobility Report, in 2019 commuters on average lost about 54 hours in traffic congestion. To combat this, major infrastructure projects have been undertaken. However, expansion projects cannot keep up with the increase in usage of personal vehicles and thus fail to address the traffic congestion problem. In addition, personal vehicles have a low occupancy rate (about 1.67 in 2019) but take up a lot of space on the roads. Transportation planners, therefore, are looking for ways to increase the efficiency of transportation systems. Commercial ride services like Uber and Lyft have recently become popular by providing flexible on-demand rides to customers. Yet these services have a negative impact on the transportation infrastructure, as they add significantly to deadhead miles—miles driven between drop-off and pickup points that do not transport passengers.

Carpool ridesharing has shown some promise in combatting this traffic congestion problem. In this system, the drivers are regular commuters who take detours to pick up and drop off passengers to decrease their transportation costs. This system increases the efficiency of the transportation system by providing flexible commutes to people, thus reducing the need for each commuter to use their own personal vehicle. Also, unlike commercial rideshare services, they do not add any deadhead miles.

For a carpool rideshare system to be effective, the drivers need to be provided with routes (i.e., rideshare routing) having minimal detours, to allow the shortest possible driving time while serving the most potential passengers. Detours occur when carpool rideshare drivers have to deviate significantly from their itinerary to pick up or drop off passengers. One way to minimize detours is through flexible pickup and drop-off points. This flexibility may require passengers to walk to or from a certain pickup or drop-off point if that decreases the travel times. Existing literature shows that flexibility has the potential to reduce the total travel time for drivers and passengers. Inspired by this idea, researchers at the University of Southern California sought to develop and test efficient routing methods for rideshare systems that take into account flexibility in pickup and drop-off locations.

The researchers developed three approaches to the rideshare routing. The first is a dynamic programming-based route enumeration approach that exhaustively generates all possible feasible routes and their respective optimum pickup and drop-off points, from which an algorithm selects the route with minimum travel time. The second is a branch-and-price approach that uses an algorithm to systematically generate simultaneous routing and pickup and drop-off points until a solution is reached. The third is another branch-and-price approach, but with sequential routing and pickup and drop-off point selection. The researchers conducted a computational study using a San Francisco taxicab dataset to determine the effectiveness of the three approaches. To show the impact of flexible meeting points, the researchers also conducted experimental simulations with and without walking and performed sensitivity analyses.

Key Research Findings

The proposed branch-and-price approaches are highly efficient. The simulations show that these approaches can solve the routing problem in a rideshare system with up to 300 origin and destination points within 130 CPU seconds (i.e., 130 seconds on a server-grade central processing unit).

Incorporating flexible pickup and drop-off points is extremely beneficial. Simulations show that incorporating passenger walking in rideshare systems can decrease travel time by 18% compared to rideshare systems with no walking.

Walking also results in less passenger waiting time and passenger in-vehicle time. A maximum of 8 minutes of walking, as compared to no walking, decreases passenger waiting time by 43%, passenger in-vehicle time by almost 21%, and total driving time by almost 13% for all vehicles in the system (Figure 1).

Passenger service rate is directly impacted by the number of drivers in the system. Sensitivity analysis shows that the number of passengers served is directly affected by the number of drivers.

Research Implications

This study shows that incorporating walking in rideshare systems can result in lower travel times, waiting times, and in-vehicle times for passengers. Thus, transportation planners should incorporate flexible pickup and drop-off locations in rideshare systems. These methodologies along with the insights the study provides about the dynamics of the rideshare systems can help policymakers design more efficient carpool rideshare systems.

More Information

This research brief is drawn from "The Ridesharing Routing Problem with Flexible Pickup and Drop-off Points," a research report from the National Center for Sustainable Transportation, authored by Maged Dessouky and Zuhayer Mahtab of the University of Southern California. The full report can be found on the NCST website at https://ncst.ucdavis.edu/project/ridesharing-routing-problem-flexible-pick-and-drop-points.

For more information about the findings presented in this brief, please contact Maged Dessouky at maged@usc.edu and Zuhayer Mahtab at mahtab@usc.edu.

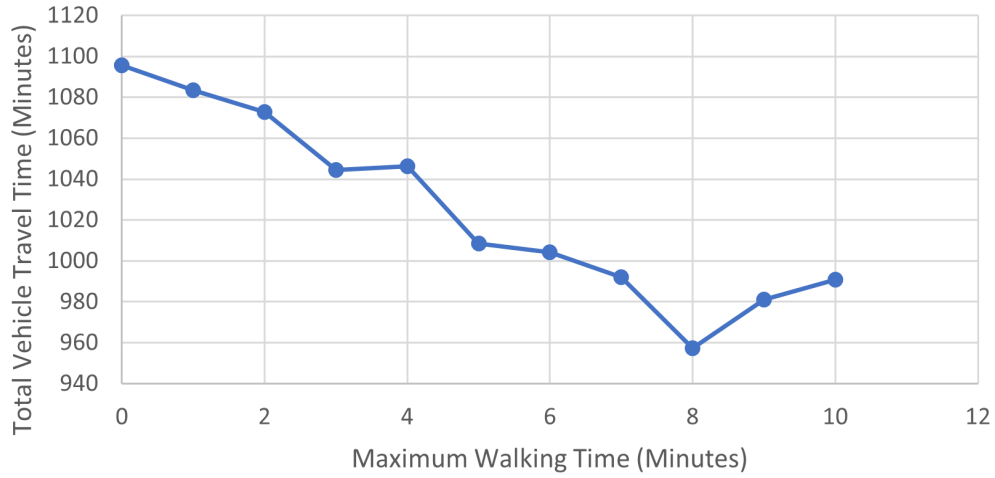

Figure 1. Effect of maximum walking time on total vehicle travel time for all vehicles in the system.

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