Sustaining Accessible Transportation Services With Ridesharing Options

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In the decades characterized by ageing population, many accessible transportation organizations face challenges to serve various needs of people sustainably due to the limited increase of social welfare expenditure. This research is motivated by an application of operations research and engineering design in community transportation service sector. We collaborate with Hong Kong's largest community transportation organization, which operates more than one hundred vehicles. The organization currently provides four types of transport services (i.e., scheduled route [SR], dial-a-ride [DAR], feeder and pooled DAR) for people with disabilities or travel inconveniences. The requirements of accessible services vary according to peoples' travelling purposes, such as going to work, school, the hospital or social activities. Various passengers also have different expectations for travelling times, affordable prices, frequency of service and pick-up and drop-off locations. This variety of service requirements poses numerous challenges for the organization to manage different services. As in the public transportation systems of many cities, these accessible transportation services operate based on different processes. In addition, this type of community transportation problem is under-studied in the literature on transportation. The developed decision models are considered as community-based operations research (CBOR). Although transportation problems with profit-driven objectives have been extensively studied, few CBOR applications and implementations have been conducted in the transportation area. CBOR decision models incorporate consideration for multiple stakeholders, and the model results serve to automate decision making and enable policy reviews.

In this research, we focus on the DAR service that has the lowest utilization of vehicle among all accessible transportation services. DAR is like a taxi service that provides door-to-door transportation on a charter basis currently. We propose a service option of ridesharing to enhance the number of passengers being served, in which passengers share a vehicle in exchange for a discounted travel rate, but which may require them to tolerate longer traveling times. The discounted rate is used as an incentive to attract more passengers for accepting the potential longer traveling time. In the first part of this research, we study how different types of accessible transportation services can be represented systematically under the same family structure with the service option of ridesharing. The identified commonality of processes among different service types will lead to the optimization of vehicle scheduling. Then, in the second part, we develop a mechanism for scheduling vehicles to evaluate the benefits of ridesharing. A decision framework is formulated into a mixed-integer programming model for two types of passengers to address the major considerations of implementing a pricing policy and a vehicle scheduling mechanism. An efficient algorithm is then proposed to merge the dial-a-ride service orders. We also design an experiment based on a data set from the organization to evaluate the relationship between user tolerance of pick-up and drop-off times and the performance of merging orders for dial-a-ride operations with ridesharing option. Finally, a survey has been conducted to collect user feedbacks for policy review. It is shown that additional 8.4% users can be served without the demand of increasing subsidy from the government according to the experimental and survey results.

Keywords: Accessible Transportation Service, Service Design, Vehicle Routing

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