Understanding & Modeling Bus Transit Driver Availability

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Mathematical models are developed to help transit agencies provide reliable and cost-optimized bus service.

To accommodate unplanned employee absences while meeting the demands of scheduled service, transit agencies employ on-call backups known as "extraboard" operators. Overestimating the appropriate number of extraboard operators has financial implications while underestimating can lead to service disruption. It is therefore important that transit agencies properly manage extraboard operator staffing.

In this study, mathematical models are developed to help transit agencies provide reliable and cost-optimized bus service. Unlike current practices, where decision makers determine the scope of the extra driver workforce using personal experience and intuition, the models developed account for measures of risk and reliability with probability distributions based on historical data. Implementing these models could potentially allow agencies to realize meaningful cost reductions while properly allocating personnel.

Study Methods

The research in this report contributes to the literature by using stochastic programming methods to address the uncertainty resulting from unexpected operator absences. Developing a global model applicable to any bus transit system is one of the main objectives of this study. The models in this report deal with the hierarchy of the tactical-level work scheduling. Therefore, the decision variable selected was the optimal number of extraboard driver hours, based on the historical driver availability data. To preserve a certain degree of operational efficiency, the models also take into account the quality-of-service, considered as a measure of reliability. The objective function of the problems (i.e., the function this study attempts to optimize) was to minimize total costs incurred by extraboard management, which include out-of-pocket agency costs as well as social costs incurred by customers who use transit vehicles. The models were therefore designed to assess the trade-off between driver costs and improved on-time performance.

Findings

The supply-and-demand data required for the model validation was obtained from historical data of the Tri-County Metropolitan Transportation District of Oregon (TriMet). Social costs are defined using clearly identified measures, estimated for the case study area, such as the value of riding per hour and the average number of passengers. The actual extraboard assignments observed in the TriMet's 7-year data are evaluated using the developed models. Only weekday and non-holiday assignments are evaluated since the models are constructed based on the probability distribution of the driver availability for these days. To illustrate scheduling performance, the overestimated numbers are compared to the optimal solutions obtained from the presented models.

At all quality-of-service levels, the Center garage extra-driver assignments are higher by at least 8.7% than the optimal solutions obtained from Model 1. This could be an indication of the extra costs associated with extra drivers that spend their workday idle. At the 90% quality-of-service level, a potentially desirable option for better service, the overestimation rates generally fall

between 0-1% for all garages except Center. This shows that the observed extra driver assignments are close to the optimal solutions obtained from the developed models.

Data and Model based Performance Evaluation: Overestimated Number of Extra Drivers

Garages	Center		Merlo		Powell	
Quality-of-Service Level	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
70%	11.40%	11.42%	7.4%	0.51%	4.50%	1.22%
80%	11.30%	6.58%	7.4%	0.20%	2.20%	0.20%
90%	8.70%	0.71%	0.6%	0.20%	0.70%	0.20%

Policy Recommendations

The authors recommend that planners and decision-makers utilize the driver absenteeism data and develop various if-then scenarios using the mathematical models similar to the ones developed in this study, and ultimately obtain comparative results for advanced decision making. For large scale implementations, the developed models also provide the flexibility of assigning different quality-of-service (i.e., reliability) levels to different garages. Such flexibility enhances the scalability of the developed models, making them applicable for transit agencies of various sizes.

About the Authors

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To Learn More

For more details about the study, download the full report at ***transweb.sjsu.edu/project/1140.html***

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