A RESOURCE SCHEDULING DECISION SUPPORT MODEL FOR MOBILE PHOTO ENFORCEMENT

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1. BACKGROUND
A mobile photo enforcement (MPE) program deploys enforcement resources (equipment and personnel) to roadway locations, using radar and license plate photos to “catch” speed-limit violators. Where and when to deploy MPE program resources is a very important part of MPE operations, which helps enforcement agencies emphasize their road safety improvement goals and helps increasing the efficiency of program resource use. However, the design of MPE programs has received little attention from researchers.

The allocation of MPE resources is a complex process. This complexity arises from the fact that the allocation of MPE resources is not stationary, but it requires moving those resources from one site to another. Therefore, when MPE program managers allocate operators and equipment to sites, they must simultaneously consider the location of the resource allocation, the time of the allocation, and the availability of resource. Due to this complexity, a tool that can assist MPE program managers in making an effective and efficient resource deployment plan becomes necessary.

2. METHOD
We developed a method to schedule MPE operators’ work shifts to enforcement locations as well as available working shifts across the planning horizon. Specifically, we constructed a pre-processing step to allocate operators to individual enforcement sites within each city neighborhood chosen for enforcement as determined in a previous resource allocation stage (Y. Li, Kim, & El-Basyouny, 2016). This pre-processing step allocated enforcement resources to sites where the safety goals set in the previous stage can be continually attained. To do this, we employed the same metrics that were used to quantify deployment goals set in the previous stage and assign enforcement operators to enforcement locations identified by the metrics.

Then, we designed a scheduling model to further distribute operators that have been paired with enforcement sites to available shifts over the planning period. We modeled a set covering formulation and solved it using a column generation method. The model aims at a highly varied and efficient shift schedule for each enforcement operator by minimizing the penalty cost incurred when selecting a feasible shift schedule into the scheduling timetable. Since increasing randomness of shift pattern (i.e., to construct unpredictable schedules) is an important MPE’s operational-level objective, the penalty costs were determined by shift intervals; the smaller the deviation of shift intervals from their average, the greater the cost of punishment. In addition, to increase efficiency of resource use, we also considered
the utilization of enforcement’s time halo effects when building the schedule by adding penalty costs of shift schedules with sequential shift assignments during each time halo.

3. RESULTS AND CONCLUSION
We applied this model to a MPE program operated by the City of Edmonton, Canada, and the model produced an efficient and seemingly random enforcement schedule allocating the program’s enforcement activities of a given month to individual enforcement sites and time (Y. Li, Kim, & El-Basyouny, 2017). In addition, we evaluated the results of the schedule provide by our model by comparing the existing deployment schemes adopted by local enforcement agency.

The contribution of this paper is that we provide MPE program managers with a tool to help them develop a goal driven, less predictable scheduling plan with efficient use of limited resources. In addition, our scheduling model is applicable for large and realistic instances.

REFERENCES