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Demand-point constrained EMS vehicle allocation problems for regions with both urban and rural areas

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Abstract Governments deal with increasing health care demand and costs, while budgets are tightened. At the same time, ambulance providers are expected to deliver high-quality service at affordable cost. Maximum reliability and minimal availability models guarantee a minimal performance level at *each* demand point, in contrast to the majority of facility location and allocation methods that guarantee a minimal performance that is *aggregated* over the entire ambulance region. As a consequence, existing models generally lead to overstaffing, particularly in 'mixed' regions with both urban and rural areas, which leads to unnecessarily high costs. This paper addresses this problem. First, we introduce the concept of *demand projection* to give fundamental insight into why this overstaffing takes place. Next, we overcome the overstaffing by the so-called *adjusted queuing* (AQ) solution that provides generalizations of the existing models. We provide mathematical proofs for the correctness of the AQ solution. Finally, to assess the performance of the AQ-solution we have performed extensive numerical experimentation, using real data from four ambulance regions in the Netherlands. The results show that in all cases the AQ-solution indeed leads to better ambulance care than the existing solutions, while reducing staffing cost.

Keywords EMS, ambulance, allocation, facility location, reliability, queuing theory

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