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Abstract

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Facility Location Optimization by Integrated Approach of Statistical Modeling and Mathematical Optimization for Emergency Road Service

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The quick delivery of Emergency Road Service (ERS) to rescue vehicles that suddenly break down during operation is an essential task for maintaining meticulously planned logistics and transportation network of the modern society. To improve transportation efficiency and customer satisfaction, ERS must arrive at the accident site as soon as possible after receiving an emergency call. A possible approach to realize a quick arrival is planning optimized locations for the service base shops.

When considering the FLP of an ERS, we must consider various and uncertain factors to influence the time from call of emergence to arrival at the accident site. The waiting time for ERS users consists of preparation time and travel time of service car. The former is affected by the situation of each trouble (such as the time of occurrence, type of vehicle trouble, and need for replacement parts) and the characteristics of each shop (such as the response capacity determined by the number of people on standby, the number of service vehicles owned, and the available equipment). Similarly, the latter is influenced by traffic conditions, for example, different times of the day or weather. Additionally, a shop may not be able to provide a rescue car for an accident that has occurred near the shop because for example, the shop may be closed that day, or a rescue car of the shop may have already been provided for another accident. In FLP of real ERS situation, we should consider such various and uncertain factors of each trouble for a better ERS.

We propose a novel and simple analytical framework to incorporate the various factors in real ERS situations to reduce the waiting time of ERS users. The analytical framework uses in combination statistical modeling for ERS user waiting times, which are subject to change due to various factors, and mathematical optimization techniques, including a novel optimization model that incorporates the probability that a shop cannot provide a service car.

We applied the proposed method to an actual record of emergency road services from Bridgestone Corporation and attempted to determine the optimal shop locations to deliver services in the shortest time. The results show that the proposed method reduced the waiting time by up to 27% compared with the conventional method considering only travel distance.