Robust Crew Recovery in Air Transportation: Reserve-Crew Scheduling to Mitigate Risks

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Abstract

Due to a significant growth in air traffic, airports are becoming increasingly congested. Consequently, efficient and effective disruption management is becoming more crucial for hub-and-spoke airlines. The airline's capability to deal with inevitable disruptions such as crew absenteeism and sudden aircraft unavailability depends predominantly on the flexibility of an airline's (reserve) crew schedule. We hereby study a novel airline crew recovery problem in which regular and reserve-crew schedules are jointly determined in a robust way. Besides repairing a disrupted schedule in a cost-efficient way, flexibility is maintained in order to cope with additional future disruptions. The flexibility in reserve crew usage is explicitly considered through evaluating the expected shortfall of an airline's underlying reserve crew schedule based on a Markov chain formulation. We propose a set-covering formulation for, the Robust Crew Recovery Problem (RCRP), which encapsulates this flexibility notion for reserve crew usage. A tailored branch-and-price algorithm is developed for solving the problem to optimality where the pricing problems are solved by a pulse algorithm. Experiments on real-life data from a medium-sized Dutch carrier show that the RCRP outperforms traditional recovery models in delivering a more stable schedule for the day of execution, which leads to a reduced amount of last-minute crew alterations (and subsequent delays) and even a reduced amount of cancellations due to lack of crew. This is especially important for a carrier operating in a hub-and-spoke network, in which the reserve crew members are located at the main hub from which the aircraft rotations are departing.

Keywords: Airline Operations, Disruption Management, Branch, and, Price Algorithm, Reserve Crew, Robust

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