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Simultaneous recovery model for aircraft and passengers ☆

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Abstract

Usually some unforeseen events make airlines to reconstruct their schedules. A mathematical model for airlines schedule recovery which recovers aircrafts and disrupted passengers simultaneously is presented in this study. Aircraft recovery decisions affect on passengers but disrupted passengers and recovering them were not explicitly considered in the most previous aircraft recovery models so recovery of these two resources – aircrafts and passengers – concurrently is one of our contributions.

The modeling is based on defining the recovery scope as well as employing aircraft rotations and passengers' itineraries instead of flights. These are two of our other contributions.

Our model examines possible flight re-timing, aircraft swapping, ferrying, utilization of reserve aircrafts, cancellation, and passenger reassignment to generate an efficient schedule recovery plan.

Model parameters are user-specific therefore it helps airlines to apply their policies in the model. Defining the recovery scope reduces the problem size and ensures that the schedule returns to normal within a certain time. The objective is in the form of cost minimization which involves three kinds of cost—operational aircraft recovery, flight cancellation, and delay as well as disrupted passengers. A data set with two disruption scenarios is used to test the proposed model. The computational results show that it is capable of handling the simultaneous aircraft and passenger recovery problem successfully.

Keywords: Airline scheduling; Disruption management; Aircraft and passenger recovery; Modeling

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1. Introduction

The operation of a passenger airline requires the allocation of resources and development of schedule plans over complex networks. Large airlines can operate over a thousand flight departures per day with several hundred aircrafts and thousands of cockpit and cabin crew employees. These resources are costly. The efficient utilization of costly resources is thus one of the key challenges faced by airlines hoping to control operating expenses to generate profits in an increasingly competitive fare environment [1]. Hence, airlines spend too much time, effort, and financial resources on planning.

Various events ranging from severe weather to the crewmember unavailability inhibit their ability to always satisfy their schedules and disrupt schedules. Disruption can be defined as an act of delaying or interrupting the continuity [2]. If such disruptions are not managed properly and timely, they will severely affect the airlines performance in terms of revenue, operational efficiency, and customer satisfaction. When disruptions occur, airlines adjust their flight operations by delaying flight departures, canceling flights, rerouting aircraft, reassigning crews or calling in new crews, and re-accommodating passengers. The objective is to get feasible, cost-minimizing plans that allow the airline to recover from the disruptions and their associated delays [3]. This problem has been studied since last three decades and in different names such as: Flight/Schedule/Airline Perturbation, Schedule Disturbances, Irregular Airline Operations Control, Operational Airline Scheduling, Day of Operations Scheduling, Real-Time Flight Scheduling, Flight Rescheduling, Disruption Management, Airline/Schedule/Flight Recovery.

Crew, aircraft, and passengers are the most important aspects of airline disruption management, but other resources such as ground staff, catering, and gates also need consideration. However these resources are usually more flexible and less expensive [4]. Nowadays, in the airline industry, recovery plans are determined in a primarily sequential manner, first recovering aircraft, then crew, and finally passengers ([5] cited in [6]).

Occurring schedule disruptions, the aircraft recovery problem is to decide flight re-timings and cancellations, and revised routings for affected aircraft. Rerouting options include ferrying, diverting, over-flying, and swapping. These adjustments must meet with maintenance requirements, station departure curfew restrictions, and aircraft balance requirements, especially at the beginning and at the end of the recovery period. At the end of the period, aircraft types should be positioned to resume operations as planned [3]. Teodorovic and Guberinic [7] were one of the first who studied the aircraft recovery from an operation research view. They considered a situation where an aircraft is taken out of service and made an effort to minimize the total passenger delay by swapping and delaying flights. The proposed model is solved exactly by a branch and bound (B&B) algorithm. More detailed explanation of concepts and models in aircraft recovery problem can be obtained in Yu and Qi [8], Kohl et al. [9], Anderson and Varbrand [10], Filar et al. [5], and Clarke [11].

Solving the aircraft recovery problems can result in disrupted passengers. Delaying or re-timing the departure of a flight will directly affect the passengers on that particular flight. It can also, indirectly, affect the passengers on the next flight in the route for the aircraft in question, if the planned ground time between the two flights is too short to cover for the delay [10]. Most of the above mentioned researches have not considered the effects of the aircraft recovery results on passengers; therefore their solutions impose significant indirect costs to airlines.