

Chapter 64

Operations Research Problems for Airline Industry: A Literature Survey for Maintenance Routing Problem

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ABSTRACT

Maintenance routing is one of the most complicated problems of operations research applications for airline industry. In this study, airline industry operations' main applications and subjects are basically mentioned and literature is briefly reviewed. This study is conducted under the headings of; Fleet Assignment, Aircraft Routing, Maintenance Routing and Crew Scheduling. Additionally, network models are explained basically on an example flight program. This study's purpose is to be a guide for the new researchers of this area through operations research applications for airline industry and to introduce maintenance routing problem literature.

INTRODUCTION

Commercial aviation industry has been providing the safest and quickest means of travel between cities for almost a century. Since 1960s, many studies were prepared in operations research literature for this industry which had become a big business area in a very short span of time.

Operations research applications for airline industry has been divided into four main categories which are "Fleet Assignment", "Aircraft Routing", "Maintenance Routing" and "Crew Scheduling". Fleet assignment problems are mainly related to determine the fleet with provided aircraft should take a given route. These fleets sometimes consist of one type of planes, and sometimes they consist of a few different models gathered together. In mixed fleets, there are planes with a variety of capacity and ranges

DOI: 10.4018/978-1-7998-5357-2.ch064

to satisfy all the requirements. Aircraft routing is mainly a tail assignment task which tries to assign planes to the given flights. While planning a flight schedule, one of the most important points is to take into account the maintenance time for the plane in accordance to permitted remaining flight hours. Each aircraft requires a distinctive scheduled maintenance. Intervals of those maintenances are regulated by Federal Aviation Administration (FAA). These maintenances types are classified as medium, long term maintenances and before flight controls. Long term maintenances and before flight checks are not listed in weekly flight plan. Because, for the long-term maintenances, the plane needs to be out off the fleet and took into the hangar; before flight checks take a very little span of time before each flight which can be ignored. Medium term maintenances, regulated by Federal Aviation Administration (FAA) regulations, require the plane to be taken into hangar for part changes. In general, hangar maintainances are planned during night hours, at which relatively small number of flights are scheduled, to prevent an overlap with flights. For the reasons listed above, taking the remaining flight time into consideration while making flight plans grant undeniable advantage to keep the planes active. Crew scheduling, as the last class of the problems, works to assign pilots and cabin attendants to flights.

This paper aims to give an insight for the operations research applications of airline industry and spesifically a literature review is given for the maintainance routing problem. In the next section, operations research problems for airline industry is given and explained briefly. In the third section, a literature review for the maintainance routing problem is prepared and the final section is the conclusion section.

OPERATIONS RESEARCH APPLICATIONS IN AIRLINE INDUSTRY

Network Models

To provide a visual overview of the problem, usually time-line networks, time-band networks or connection networks are used. These are the most widely used networking types for operations research studies in the area of airline planning. Clausen (2009) explained these most used network models. As an example, a flight plan established for Example Airlines is shown in Table 1. In this table, İstanbul(IST), Ankara(ANK), İzmir(IZM) and Antalya(ANT) have been connected together with specific flights and defined flight times. For Istanbul and Ankara airports, defined turn-around time is 60 minutes. For İzmir and Antalya, defined turn-around time is 30 minutes.

Connection Network

Connection networks are often seen as activity-on-node type of network. In connection networks, nodes represent flight legs. As an other component, lines connecting nodes represent the connection between flight legs. A boarding point, a landing point, take off and arriving times and dates create a flight leg. If it is possible to assign a plane to a flight, turn-around times in airports and airports themselves should be considered. For the flights through points l_i and l_j , the nodes representing these flights can be connected with (i, j) line. Additionally, the approximate starting and ending positions of fleet's planes' planning periods are defined as starting and ending nodes. Serial, consecutive flights, which are connected together in connection networks, are described as route. Even though the nodes do not provide clear and explicit information about flights on connection network, the information above them are detailed. Maintenance aided route concept means a route that can be used when and if a need for full fledged maintenance is

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