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MINIMIZATION OF CABIN CREW LAYOVER TIME

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Abstract: The Airline Industry is one of the top financial sectors of India. India is expected to overtake China and the United States as the world's third-largest air passenger market in the next ten years, by 2030, according to the International Air Transport Association (IATA). Despite all this in most airlines, crew costs are the second largest direct operation cost next to the fuel costs. But unlike the fuel costs, a considerable portion of the crew costs can be saved through optimized utilization of the internal resources of an airline company. And the saving is largely realized through solving the crew pairing problem. In this paper, we present a comprehensive problem definition for the airline crew scheduling problem by taking one of the airlines as a case study and try to get an optimal solution.

***Index Terms* - Airlines, Crew pairing, Fuel costs, Optimal solution.**

I. INTRODUCTION

The airline industry and its operations have been a major focus of operation researchers, especially since the advent of the jet age in the late 1950s, which was followed by major technological advances. The industry has become a significant economic force from two perspectives: its own operations and its impact on related industries such as tourism and aircraft manufacturing. The revenue mainly comes from passenger tickets, while the costs include airplane expenses, fuel, crew, and equipment. The total profit is a complicated function of all of the operations. In addition, the recent appearance of low-fare airlines has increased the pressure to provide affordable tickets and reemphasized the importance of minimizing expenses. As a result, the airline crew scheduling problem has received much attention in both industry and academia.

II. BACKGROUND

Airline scheduling consists of the following five planning stages:
1) **Flight Schedule**: A schedule consisting of all flights to be flown is constructed. The construction is typically based on market demands for the flight segments. For example, we may schedule a flight from Bengaluru to New Delhi departing on all days at various times.
2) **Fleet Assignment:** In this stage, available aircrafts are allocated to flight legs. The revenue from a flight leg depends on the market for the flight leg and the size of the aircraft that is used for the leg. The objective is to maximize revenue with the constraint that requires all the flight legs to be flown using the fleet that is available. Several other constraints also have to be satisfied.
3) **Aircraft Routing:** The aircraft routing problem involves the routing of aircraft such that maintenance constraints are satisfied; all flights flown by the fleet are covered and through revenues are maximized.
4) **Crew Pairings:** A pairing is a sequence of flight legs or segments that begin and end at a crew base such that in a sequence the arrival city of a flight leg coincides with the departure city of the next flight leg. It is also referred to by some as a trip or rotation. Each pairing has a cost associated with it. The objective is to find a subset of these pairings with minimal cost that covers all the flight legs in the schedule exactly once (sometimes more than once depending on the model used for this stage). As in the previous stage a large number of regulations and other constraints apply during this stage also.
5) **Bidlines/Rosters:** In this stage a monthly schedule that can be flown by the crew is drawn using the optimal set of pairings generated from the previous stage. This monthly schedule is called a bidline (or roster) for the crew. It is called bidline because pilots can bid on the generated lines based on seniority and other considerations. This stage determines the exact number of cockpit crew members that the airline will require for the month. Again, each bidline/roster must satisfy several constraints similar to the previous two stages.
The last two stages in airline planning are usually referred to as airline crew scheduling. The crew scheduling process begins with the daily crew-pairing optimization problem.

III. PROBLEM DESCRIPTION

Airline crew scheduling is the problem of assigning a group of crew members to a set of scheduled flights such that all the scheduled flights are covered while the rules and collective agreements, imposed mainly by safety and labor organizations, are respected. The complex restrictions make this one of the most difficult crew scheduling problems in the transportation industry.

In this paper, we have taken a case study of INDIGO Airlines for crew scheduling one of the airlines as a case study and try to get an optimal solution.

IV. CASE STUDY OF INDIGO AIRLINES

InterGlobe Aviation Ltd., doing business as IndiGo, is an Indian low cost airline headquartered in Gurgaon, Haryana , INDIA It is the largest airline in India by passengers carried. The airline has carried over 300+ million passengers as of November 2022. The airline operates 1,600 daily flights, as of November 2022 to 101 destinations – 75 domestic and 26 international. INDIGO has been ranked as the 4th most punctual airline globally in 2018, 6th most punctual airline globally in 2019 and 3rd most punctual airline globally in 2021 by OAG (Official Airline Guide) Punctuality League.

INDIGO operates
13 flights from Bengaluru (BLR) to Delhi (DEL)
14 flights from Delhi (DEL) to Bengaluru (BLR)
For this work we have considered 5 flights

Table 1: Flight Schedule

Flight #	BLR Departure	DEL Arrival	Flight #	DEL Departure	BLR Arrival
6E-2433	07:00	09:50	6E-6612	05:55	08:45
6E-871	09:50	12:40	6E-5608	09:15	12:05
6E-2401	13:45	16:45	6E-5088	13:05	15:55
6E-2174	18:00	20:50	6E-6622	19:20	22:05
6E-735	19:15	22:10	6E-2515	20:30	23:25

Table 2: Crew Based in Bengaluru (BLR)

DEL Arrival – DEL Departure					
	6E-6612	**6E-5608**	**6E-5088**	**6E-6622**	**6E-2515**
6E-2433	20.05	23.35	15.15	09.30	10.40
6E-871	17.15	20.35	24.25	06.40	07.50
6E-2401	13.10	16.30	20.20	26.35	27.45
6E-2174	09.05	12.25	16.15	22.30	23.40
6E-735	07.45	11.05	14.55	21.10	22.20

Table 3: Crew Based in Delhi (DEL)

BLR Arrival – BLR Departure					
	6E-6612	**6E-5608**	**6E-5088**	**6E-6622**	**6E-2515**
6E-2433	22.15	18.55	15.05	08.55	07.35
6E-871	25.05	21.45	17.55	11.45	10.25
6E-2401	29.00	25.40	21.50	15.40	14.25
6E-2174	09.15	29.55	26.05	19.55	18.35
6E-735	10.40	07.10	27.20	21.10	19.50

Considering 5 minutes as 1 unit

Table 4: Crew Based in Bengaluru (BLR)

	6E-6612	6E-5608	6E-5088	6E-6622	6E-2515
6E-2433	241	283	183	114	128
6E-871	207	247	293	80	94
6E-2401	158	198	244	319	333
6E-2174	109	149	195	270	284
6E-735	93	133	179	254	268

Table 5: Crew Based in Delhi (DEL)

	6E-6612	6E-5608	6E-5088	6E-6622	6E-2515
6E-2433	267	227	181	107	91
6E-871	301	261	215	141	125
6E-2401	348	308	262	188	172
6E-2174	111	359	313	239	223
6E-735	126	86	328	254	238

V. RESULTS AND DISCUSSION

5.1 Computational Results

Table 6: Final Layover table (* Represents crew based in BLR)

241*	227	181	107	91
207*	247*	215	80*	94*
158*	198*	244*	188	172
109*	149*	195*	239	223
93*	86	179	254	238

Table 7: Final Assignment is shown to depict the best possible order of flights that can optimize time

Flight # for Arrival	Flight # for Departure	Layover time
6E-2433	6E-6612	91*5=455m
6E-871	6E-5608	80*5=400m
6E-2401	6E-5088	158*5=790m
6E-2174	6E-6622	195*5=975m
6E-735	6E-2515	86*5=430m

Total layover time = 3050m
i.e 50h 83m
The highest layover time is given to the crew for Flight# 6E-2174 while the most efficient crew is for the Flight# 6E-871.
As the number of layover hours goes on increasing, it is reflective of the decreasing efficiency of the crew.

5.2 CONCLUSION

In this paper, we made an attempt to solve airline crew scheduling problems by generating feasible combination of crew routes and balancing them out. The performance of the proposed algorithm was tested for its efficiency and it is worth mentioning that it was fast in comparison with manually crew pair generation. Although the algorithm was able to solve the main problem that is related to crew route generation and balancing, it still needs further improvement to enable it generate petalsolutions and local search. We also recommend a further study on other algorithms like using the biased randomization to obtain a random and feasible crew pairs can be applied as a future work.

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