

# Route Scheduling of Air India Flights between Mumbai and Delhi

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## Abstract

*Aim of this study was to re-schedule flights between Mumbai and Delhi for eleven schedules to reduce the rest periods for crew members when they stay at Mumbai and Delhi; which results in improving the utility of the resources to a greater extent. The problem was formulated as an assignment problem with eleven schedules from Mumbai to Delhi and back. Hungarian Method was used to solve the problem using OR software. Results reveals that by re-scheduling flights between Mumbai and Delhi rest period for the crew was reduced considerably about 32%.*

**Key words:** Routes, Schedules, Rest Period, Assignment

## 1. INTRODUCTION:

Air India occupies a special place in the global and Indian aviation scenario. It pioneered the aviation in India and its history is synonymous with the history of civil aviation in India. Air India was once the largest operator in the Indian subcontinent with a market share of over 60%. Indifferent financial performance and service, labor trouble pushed it to fourth place in India, behind low cost carriers like IndiGo, SpiceJet, and its full service rival Jet Airways. Between September 2007 and May 2011, Air India's domestic market share declined from 19.2% to 14%, primarily because of stiff competition from private Indian carriers. However, after financial restructuring and enforcement of strict rules and regulations, the airlines showed signs of turning around. In March 2013, the airlines posted its positive earnings after almost 6 years. Hence, the study was undertaken at Air India to improve its domestic market share for its survival.

### 1.1 About Air India:

Air India, the premier flight carrier of India is one of the most extensive flight service providers in India. It is owned by Air India Limited (AIL), a Government of India enterprise. Air India Limited is a company that was formed as National Aviation Company of India Limited (NACIL) by the government of India to oversee the merger of Air India and Indian Airlines on 27 February 2011. Air India Limited is the third largest airline in India with a market share of above 19% (after IndiGo and Jet Airways) in domestic market share, and operates a fleet of Airbus and Boeing aircraft serving various domestic and international airports. It is headquartered at

the *Indian Airlines House* in New Delhi. Air India has two major domestic hubs at Indira Gandhi International Airport and Chhatrapati Shivaji International Airport, and secondary hubs at Chennai International Airport and Netaji Subhas Chandra Bose International Airport, Kolkata.

Air India serves 60 domestic destinations and 31 international destinations in 19 countries across Australia, Asia, Europe and North America. Air India's short-haul routes mainly include domestic cities and Airbus A320 family is used for the same. The Airbus A320 family consists of short- to medium-range, narrow-body, commercial passenger twin-engine jet airliners manufactured by Airbus. The family includes the A318, A319, A320 and A321, as well as the ACJ business jet. The aircraft family can accommodate up to 220 passengers and has a range of 3,100 to 12,000 km (1,700 to 6,500 nmi), depending on model.

## 2. STATEMENT OF THE PROBLEM:

One of the major schedules of domestic destination was the route between Mumbai and Delhi. From the existing time schedule obtained from Air India it was found that 22 individual schedules were planned from Delhi to Mumbai and back. Out of which 11 schedules from both cities were direct routes for which flight time between the cities was found to be 2 Hrs. The rest period for crew members was found to be 144Hrs for the existing schedule. The schedule of flights is shown in table1. Hence the re-scheduling the schedules of flights was found essential.

Table 1: Schedule of Direct Flights between Delhi to Mumbai								
Delhi to Mumbai				Mumbai to Delhi				Rest Period In Hrs
Flight No.	Departure	Arrival		Flight No.	Departure	Arrival		
1	AI 349	4:00	6:15	1	AI 348	8:15	10:30	2.00
2	AI 657	7:00	9:15	2	AI 658	18:00	20:15	8.45
3	AI 665	8:00	10:15	3	AI 666	15:00	17:00	4.45
4	AI 887	9:00	11:15	4	AI 888	19:00	21:00	7.45
4	AI 865	10:00	12:15	5	AI 866	9:00	11:15	20.45
6	AI 810	16:00	18:15	6	AI 809	7:00	9:10	12.45
7	AI 659	17:00	19:15	7	AI 660	17:00	19:00	21.45
8	AI 863	18:00	20:15	8	AI 864	11:00	13:15	14.45
9	AI 805	20:00	22:15	9	AI 806	8:00	10:15	9.45
10	AI 602	21:00	23:00	10	AI 605	21:00	23:15	22.00
11	AI 315	23:00	01.00	11	AI 314	20:00	22:00	19.00

### 3. METHODOLOGY OF STUDY:

With aim of reducing the rest period for crew members of flights between Mumbai and Delhi, the following procedure were adopted.

1. Time table of schedule of Flights from Mumbai and Delhi and vice versa were collected from Air India Website. It is found that there were 11 schedules operating daily between Delhi and Mumbai as shown in table 1.
2. As Air-India has two major domestic hubs at Indira Gandhi International Airport and Chhatrapati Shivaji International Airport at Delhi, it was assumed that crew will start their schedules from Delhi. The rest period for crew were calculated for assigned flight. For Eg: Crew members of AI 349 will depart at 4AM and reach Mumbai at 6:15 AM and return back by 8.15 AM and reach Delhi by 10.30 AM with a rest period of 2Hrs. Similarly rest period for remaining routes were analysed and listed in table 1.
3. In order to find the rest period for combination of flights from Delhi to Mumbai and back viz., Flight AI 349, AI 657, AI 665, AI 887, AI 865, AI 810, AI
4. 659, AI 863, AI 805, AI 602, AI 315 with the return Flights from Mumbai viz., AI 348 AI 658 AI 666 AI 888 AI 866 AI 809 AI 660 AI 864 AI 806 AI 605 AI 314 were analysed.

5. While calculating the rest period, two tables had to be prepared considering Crew to Stay at Delhi and Mumbai. In order to simplify the table we have considered 1 hour rest period equals to 4 Units and the values are tabulated is as in table 2 and 3 when crew stay at Delhi and Mumbai respectively.
6. After calculating the rest period for each schedule, minimum rest period among the combination between flights were analysed and is tabulated and is shown in table 4.
7. Then the problem was solved as simple Assignment Problem by Hungarian Method using TORA, Operations Research software and result of same is shown in table 4.
8. Rescheduling of crew with revised schedule and the rest period for the same is shown table 5.

Table 2: Rest period for Crew when they stay at Delhi (Delhi-Mumbai)												
		1	2	3	4	5	6	7	8	9	10	11
		AI 809	AI 806	AI 348	AI 866	AI 864	AI 666	AI 660	AI 658	AI 888	AI 314	AI 605
1	AI 349	3	7	8	11	19	35	43	47	51	55	59
2	AI 657	87	91	92	95	7	23	31	35	39	43	47
3	AI 665	83	87	88	91	3	19	27	31	35	39	43
4	AI 887	79	83	84	87	95	15	23	27	31	35	39
5	AI 865	75	79	80	83	91	11	19	23	27	31	35
6	AI 810	51	55	56	59	67	83	91	95	3	7	11

7	AI 659	47	51	52	55	63	79	87	91	95	3	7
8	AI 863	43	47	48	51	59	75	83	87	91	95	3
9	AI 805	35	39	40	43	51	67	75	79	83	87	91
10	AI 602	32	36	37	40	48	64	72	76	80	84	88
11	AI 315	24	28	29	32	40	56	64	68	72	76	80

		1	2	3	4	5	6	7	8	9	10	11
		AI 809	AI 806	AI 348	AI 866	AI 864	AI 666	AI 660	AI 658	AI 888	AI 314	AI 605
1	AI 349	75	71	70	67	59	44	36	31	28	24	19
2	AI 657	87	83	82	79	71	56	48	43	40	36	31
3	AI 665	91	87	86	83	75	60	52	47	44	40	35
4	AI 887	95	91	90	87	79	64	56	51	48	44	39
5	AI 865	3	95	94	91	83	68	60	55	52	48	43
6	AI 810	27	23	22	19	11	92	84	79	76	72	67
7	AI 659	31	27	26	23	15	96	88	83	80	76	71
8	AI 863	35	31	30	27	19	4	92	87	84	80	75
9	AI 805	43	39	38	35	27	12	4	95	92	88	83
10	AI 602	47	43	42	39	31	16	8	3	96	92	87
11	AI 315	55	51	50	47	39	24	16	11	8	4	95

		1	2	3	4	5	6	7	8	9	10	11
		AI 809	AI 806	AI 348	AI 866	AI 864	AI 666	AI 660	AI 658	AI 888	AI 314	AI 605
1	AI 349	75	71	8	11	19	35	36	31	28	24	19
2	AI 657	87	83	82	79	71	23	31	35	39	36	31
3	AI 665	83	87	86	83	75	19	27	31	35	39	35
4	AI 887	79	83	84	87	79	15	23	27	31	35	39
5	AI 865	75	79	80	83	83	11	19	23	27	31	35
6	AI 810	27	23	22	19	11	83	84	79	76	72	11
7	AI 659	31	27	26	23	15	79	87	83	80	76	71
8	AI 863	35	31	30	27	19	75	92	87	84	80	75
9	AI 805	35	39	38	35	27	12	75	79	83	87	83
10	AI 602	32	36	37	39	31	16	8	76	80	84	88
11	AI 315	24	28	29	32	40	24	16	11	8	76	80

Mumbai to Delhi and back								Rest Period In Hrs
Flight No.	Departure	Arrival		Flight No.	Departure	Arrival		
1	AI 806	8:00	10:15	1	AI 349	4:00	6:15	17.45
2	AI 314	20:00	22:00	2	AI 657	7:00	9:15	9.00
3	AI 864	11:00	13:15	3	AI 810	16:00	18:15	2.45
4	AI 605	21:00	23:15	4	AI 659	17:00	19:15	17.45
4	AI 866	9:00	11:15	5	AI 863	18:00	20:15	6.45
6	AI 348	8:15	10:30	6	AI 805	20:00	22:15	9.30
7	AI 660	17:00	19:00	7	AI 602	21:00	23:00	8.00
Delhi to Mumbai and back								
8	AI 665	8:00	10:15	3	AI 658	18:00	20:10	7.45
9	AI 887	9:00	11:15	4	AI 888	19:00	21:05	7.45
10	AI 865	10:00	12:15	5	AI 666	15:00	16:55	2.45
11	AI 315	23:00	1:00+1	11	AI 809	7:00	9:10	6.00

#### 4. FINDINGS AND SUGGESTIONS:

The Route Scheduling Problem was solved through Quantitative System Package. The following observations can be interpreted.

- Rest Period for the crew was reduced from 144 Hrs to 98 Hrs Refer table 1 and Table 5.
- It was found that seven schedules AI 806, AI 314, AI 864, AI 605, AI 866, AI 348 and AI 660 were proposed to start from Mumbai than at Delhi.

- Rescheduling was resulting in saving of 46 hrs of rest period. Assuming indirect cost of rest period Rs.500 per hour, there will be saving of Rs.23,000/- per for day. Since, the flights will run regularly on all the days, considering 30 trips in a month results in saving of Rs 6.9 Lakhs.

## 5. CONCLUSION

Operations Research provides better solution in decision making. In this study we could able to apply Assignment Algorithm for re-scheduling the domestic route between Mumbai and Delhi. The Hungarian Method of Assignment Algorithm has provided an optimal Solution with reduced rest period by about 32%. This study reveals that, the application of OR techniques can applied to re-schedule the routes and can improve the utility of the resources to a greater extent.

## 6. REFERENCES

- [1] 'Significant improvements in Air India's performance parameters', Press Trust of India @indiacom, April 01, 2014. Retrieved 1st Feb 2015.
- [2] <http://www.airindia.com/time-table.htm>, 'Air India Timetable', Retrieved 15<sup>th</sup> Dec 2014.
- [3] [http://en.wikipedia.org/wiki/Air\\_India](http://en.wikipedia.org/wiki/Air_India), 'Air India', Retrieved 15<sup>th</sup> Dec 2014.
- [4] Mendis Sean (2014) 'Air India: The history of the aircraft fleet'. Retrieved 15<sup>th</sup> Dec 2014
- [5] 'Air India: Problems run deep in India's national airline', BBC News, Delhi, 16 May 2012, Retrieved 15<sup>th</sup> Dec 2014.
- [6] [http://en.wikipedia.org/wiki/Airbus\\_A320\\_family](http://en.wikipedia.org/wiki/Airbus_A320_family), 'Airbus A320 family', Retrieved 15<sup>th</sup> Dec 2014.
- [7] <http://www.airindia.in/newsdetail.htm?544>, 'About Air India', Retrieved 15th Dec 2014.
- [8] Bronson, Richard. (1997) Schaum's outline of theory and problems of Operations Research, McGraw- hill
- [9] Gupta, Prem Kumar & D.S.Das (2001) Operations Research, S.Chand &Company ltd
- [10] Sharma S.D. (2002) 'Operations Research' Kedarnath Ramnath & company publishers