Quantitative Techniques PE-261

PROFIT OPTIMIZATION OF AN PASSENGER AIRLINE COMPANY USING LP AND LINGO SOFTWARE

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13.10.2020

ACKNOWLEDGEMENT

It gives me immense pleasure to take this opportunity to acknowledge our Project mentor Dr. Saurabh Agrawal, Department of Mechanical Engineering, Delhi Technological University, who is providing us with his precious guidance. We thank him for his keen interest, moral support, invaluable suggestions and guidance.
We also appreciate the help of the Mechanical Engineering Department and all the faculty members along with the officials of Delhi Technological University for assisting us in the realization of this project.
We are thankful to our colleagues and other staff members for their support.
We take the opportunity to thank our parents and relatives for their moral support in successful completion of this project work.

ABSTRACT

Air transport has become one of the most used means of transport due to its affordability and comfort. So it has become a challenge for the airline companies to generate revenue without increasing the fare too much.So in this case study we have chosen the top 4 most busiest airports in India i.e. Delhi , Mumbai, Bengaluru and Chennai and devised a way by which we increase the profit of companies by utilizing the available slots at those airports in such a manner that maximum profit can be generated within the given constraints. We have collected the data, represented it in tabular form then formulated it and at the end we have used the **simplex algorithm** and **Lingo software** to find the optimal solution.

OBJECTIVES

1. To find the optimal number of slots for flights so that profit can be maximised**.**
2. To find an increase in total profit and develop a Lingo Model for the problem.

DATA REPRESENTATION

TABLE 1 :- DISTANCE (in kms.)

CITIES	DELHI	MUMBAI	BENGALURU	CHENNAI
DELHI	-	1148	1740	1756
MUMBAI	1148	-	845	1033
BENGALURU	1740	845	-	290
CHENNAI	1756	1033	290	-

TABLE 2 :- TOTAL EXPENDITURE (in ₹.)

CITIES	DELHI	MUMBAI	BENGALURU	CHENNAI
DELHI	-	205000	293000	295000
MUMBAI	205000	-	160000	188000
BENGALURU	293000	160000	-	77000
CHENNAI	295000	188000	77000	-

Total Expenditure= (Total Fuel x fuel cost)+ salary of staff.
Fuel Cost = ₹ 40000 per kilolitre (average of major cities in India)
Salary Of Staff= ₹ 1000000 per month (2 pilots + 6 crew) (Average used)
Per Flight= ₹34000 approx. Fuel Used =3.720 litres per kilometre

TABLE 3 :- TOTAL PROFIT (in ₹.)

CITIES	DELHI	MUMBAI	BENGALURU	CHENNAI

DELHI	-	198000	134000	114000
MUMBAI	198000	-	160000	200000
BENGALURU	134000	160000	-	118000
CHENNAI	114000	200000	118000	-

Total Income Earned= (Total Passengers x Fare one way) - (Total Expenditure)
Total Profit= Total Income - Total Expenditure (total 160 passengers)

TABLE 4 :- SLOTS

CITIES	DELHI	MUMBAI	BENGALURU	CHENNAI	TOTAL
DELHI	-	8	5	5	18
MUMBAI	9	-	4	3	16
BENGALURU	6	4	-	2	12
CHENNAI	5	3	3	-	11
TOTAL	20	15	12	10	

FORMULATION

Max $198000x_{12} + 134000x_{13} + 114000x_{14} + 198000x_{21} + 160000x_{23} + 200000x_{24} + 134000x_{31} + 160000x_{32} + 118000x_{34} + 114000x_{41} + 200000x_{42} + 118000x_{43}$

Subject to :-

$x_{13}>=1$,$x_{23}>=1$,$x_{32}>=1$,$x_{42}>=1$ $x_{13}<=8$,$x_{23}<=8$,$x_{32}<=8$,$x_{42}<=8$

$x_{12}>=1$, $x_{21}>=1$,$x_{31}>=1$,$x_{41}>=1$ $x_{14}<=8$,$x_{24}<=8$,$x_{34}<=8$,$x_{43}<=8$

$x_{14}>=1$,$x_{24}>=1$,$x_{34}>=1$,$x_{43}>=1$ $x_{12}<=8$, $x_{21}<=8$,$x_{31}<=8$,$x_{41}<=8$

$x_{21}+x_{23}+x_{24}<=16$ $x_{41}+x_{42}+x_{43}<=11$ $x_{21}+x_{32}+x_{41}<=20$

$x_{12}+x_{32}+x_{42}<=15$ $x_{13}+x_{23}+x_{43}<=12$ $x_{14}+x_{24}+x_{34}<=10$

$x_{31}+x_{32}+x_{34}<=12$ $x_{12}+x_{13}+x_{14}<=18$ (For total number of slots)

LINDO MODEL FOR PROFIT OPTIMIZATION

TABLE 5 :- SLOTS AFTER OPTIMIZATION

CITIES	DELHI	MUMBAI	BENGALURU	CHENNAI	TOTAL
DELHI	-	8	8	2	18
MUMBAI	8	-	1	7	16
BENGALURU	8	3	-	1	12
CHENNAI	4	4	3	-	11
TOTAL	20	15	12	10	

Profit before Slot optimization=₹ 9050000
Profit after Slot optimization=₹ 9308000
Profit in a day = ₹ 258000
Increase in profit in a year = ₹ 9417000

Lingo 19.0 - [Lindo Model - Lingo3]

File Edit Solver Window Help

```
!Objective function;
Max 198000x12 + 134000x13 + 114000x14 + 198000x21 + 160000x23 + 200000x24 + 134000x31 + 160000x32 + 118000x34 +114000x41 + 200000x42 + 118000x43

s.t.

x21 + x23 + x24 <= 16
x41 + x42 + x43 <= 11
x21 + x32 + x41 <= 20
x12 + x32 + x42 <= 15
x13 + x23 + x43 <= 12
x14 + x24 + x34 <= 10
x31 + x32 + x34 <= 12
x12 + x13 + x14 <= 18
!Constraints to make sure we don't have negative Slots;
x12>=1 x21>=1 x31>=1 x41>=1
x13>=1 x23>=1 x32>=1 x42>=1
x14>=1 x24>=1 x34>=1 x43>=1

x12<=8 x21<=8 x31<=8 x41<=8
x13<=8 x23<=8 x32<=8 x42<=8
x14<=8 x24<=8 x34<=8 x43<=8

end

GIN x12 GIN x21 GIN x31 GIN x41
GIN x13 GIN x23 GIN x32 GIN x42
GIN x14 GIN x24 GIN x34 GIN x43
```

```
LINGO/WIN64 19.0.24 (26 Oct 2020), LINDO API 13.0.4099.

Licensee info: Eval Use Only
License expires: 10 MAY 2021

Global optimal solution found.
Objective value:                              9308000.
Objective bound:                              9308000.
Infeasibilities:                              0.000000
Extended solver steps:                               0
Total solver iterations:                             9
Elapsed runtime seconds:                          1.32

Model Class:                                      PILP

Total variables:                 12
Nonlinear variables:              0
Integer variables:               12

Total constraints:               33
Nonlinear constraints:            0

Total nonzeros:                  60
Nonlinear nonzeros:               0
```

Variable	Value	Reduced Cost
X12	8.000000	-198000.0
X13	8.000000	-134000.0
X14	2.000000	-114000.0
X21	8.000000	-198000.0
X23	1.000000	-160000.0
X24	7.000000	-200000.0
X31	8.000000	-134000.0
X32	3.000000	-160000.0
X34	1.000000	-118000.0
X41	4.000000	-114000.0
X42	4.000000	-200000.0
X43	3.000000	-118000.0

Row	Slack or Surplus	Dual Price
1	9308000.	1.000000
2	0.000000	0.000000
3	0.000000	0.000000
4	5.000000	0.000000
5	0.000000	0.000000
6	0.000000	0.000000
7	0.000000	0.000000
8	0.000000	0.000000
9	0.000000	0.000000
10	7.000000	0.000000
11	7.000000	0.000000
12	7.000000	0.000000
13	3.000000	0.000000
14	7.000000	0.000000
15	0.000000	0.000000
16	2.000000	0.000000
17	3.000000	0.000000
18	1.000000	0.000000
19	6.000000	0.000000
20	0.000000	0.000000
21	2.000000	0.000000
22	0.000000	0.000000
23	0.000000	0.000000
24	0.000000	0.000000
25	4.000000	0.000000
26	0.000000	0.000000
27	7.000000	0.000000
28	5.000000	0.000000
29	4.000000	0.000000
30	6.000000	0.000000
31	1.000000	0.000000
32	7.000000	0.000000
33	5.000000	0.000000

RESULT

1. We did the slot utilization of 4 major and busiest airports in India i.e. Delhi, Mumbai, Bengaluru, Chennai .The optimized result now makes proper use of the available slots between these cities . A net profit of INR 258000 (approx.) per day was increased which led to approx INR 9.5 Crores increase in revenue of budget airlines per year between only 4 cities.
2. If this model is applied on a larger part or cities of the airline company there will be a great increase to the revenue of the company. This model can also be used in other sectors of the airline industry such as staff scheduling ,Boarding procedure, vehicle scheduling and maintenance of aircrafts.

CONCLUSION

1. By doing formulation of a linear programming problem and using LINGO programming and solver the profit of a company can be increased to considerable amount as shown in this case study .This step could turn out to be a great plan and prevent companies like jet airways from bankruptcy.
2. This case study can also be applied to other transport industries mainly public transports like Local bus services ,Train slots and number of coaches in a specific train can also be optimized according to profit across the country.It can also be used for staff scheduling ,Route structuring.

REFERENCES

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