Airline Economics – Planning and Key Performance Indicators Practical Guide for Students

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This paper is a practical guide to assist students in understanding the Key Performance Indicators of airline economics and the relationships between them. This assistance will be materialised in the form of an example of calculating and presenting the core economic indicators of a hypothetical airline. A simplified one-year operational and financial plan will be assembled. This guide is intended to be used as the basis for class discussions.

Keywords: profit, planning, yield, network effect

INTRODUCTION

There are numerous students among my readers on the Academia.edu web site. I have decided to prepare a practical guide to assist students in understanding the Key Performance Indicators of airline economics and the relationships between them. This assistance will be materialised in the form of an example of calculating and presenting the core economic indicators of a hypothetical airline. The equations applied in this paper are laid down in my previous paper (AIRLINE PROFIT EQUATION REVISED - Back to the basics) published on the Academia.edu website. To be consistent with my previous paper as much as possible, I use the same notation (see Appendix 5.1) throughout the remainder of this paper.

I will set up a simplified airline. All the data are estimations based on certain assumptions. The student may replace them with real data. Having set up my airline, I put together a one-year operational and financial plan. As a simplification, I disregard detailed airline schedule and cost calculations in the plan.

The planning phase is followed with a **What-If** analysis to show the relationships between the Profit Drivers (load factor, yield and unit cost).

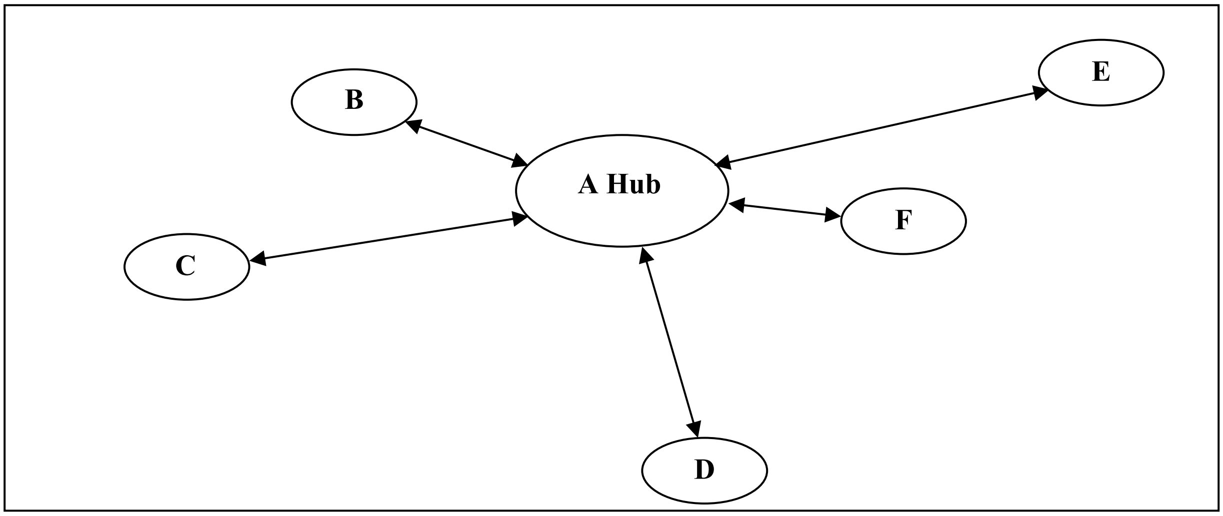
The name of this hypothetical airline is "MyAir"; I concentrate on the passenger transportation sector in this paper.

SETTING UP THE AIRLINE

Network

Let's choose a simple hub and spoke network with six airports connected from Hub **A** (Figure 1).

FIGURE 1
LENGTH OF ARROWS REFLECTS THE DISTANCE FROM THE HUB



Airport locations, ICAO codes and countries (Table 1) are not specified in my hypothetical airline. Students should choose real airports when they are setting up their own airline.

TABLE 1
AIRPORTS

Airport location (City/Hub)	Airport ICAO code	Country
A	TBA	TBA
B	TBA	TBA
C	TBA	TBA
D	TBA	TBA
E	TBA	TBA
F	TBA	TBA

TBA - To Be Advised

The flight stage distances are set by me (Table 2). Students should apply the real Great Circle Distances. It is seen from the table that there is a mix of medium-haul and long-haul flights. The aim is to demonstrate the impact of the network effect on the revenue output (see Chapter 3.3).

TABLE 2
FLIGHT STAGE DISTANCES BY GCD (km)

No.	Departure Airport	Arrival Airport	Flight stage distances by GCD* (km)
1	A	B	2,200
2	B	A	2,200
3	A	C	8,250
4	C	A	8,250
5	A	D	9,200
6	D	A	9,200
7	A	E	8,500

8	E	A	8,500
9	A	F	1,600
10	F	A	1,600

GCD* Great Circle Distance

Demand

The passenger demand (Table 3) on our network is set intentionally (based on the "previous year's" actual figures). Our demand consists of both tourist and business passengers.

TABLE 3
DEMAND

No.	City pairs (stages)	Revenue passengers (one year)		
		Y (Tourist)	B (Business)	Total
1	A-B	25,800	1,300	27,100
2	B-A	25,800	1,300	27,100
3	A-C	13,100	900	14,000
4	C-A	13,100	900	14,000
5	A-D	13,600	1,100	14,700
6	D-A	13,600	1,100	14,700
7	A-E	14,100	850	14,950
8	E-A	14,100	850	14,950
9	A-F	26,200	1,400	27,600
10	F-A	26,200	1,400	27,600
	Total	**185,600**	**11,100**	**196,700**

Aircraft Utilisation

We have the "previous year's" schedule from which the number of departures per year can be defined (Table 4). I have tried to put together realistic figures.

TABLE 4
AIRCRAFT UTILIZATION

No.	City pairs (stages)	Block Time (h)	Departures	Block time/year (h)	Block speed (km/h)
1	A-B	3.2	96	307.2	688
2	B-A	3.2	96	307.2	688
3	A-C	11.0	48	528.0	750
4	C-A	11.0	48	528.0	750
5	A-D	11.5	48	552.0	800
6	D-A	11.5	48	552.0	800
7	A-E	11.0	48	528.0	773
8	E-A	11.0	48	528.0	773
9	A-F	2.5	96	240.0	640
10	F-A	2.5	96	240.0	640
		Total	**672**	**4,310.4**	
		Average utilisation (h/day)		11.97	

Block hours are the industry standard measure of aircraft utilisation. The average daily utilisation should be around the industry average.

Reminder: The total amount of time a flight takes—from pushing back from the departure gate ("off-blocks") to arriving at the destination gate ("on-blocks")—is called the "block time". Block time includes the time to taxi-out to the runway, the actual flight duration and the time to taxi to the arrival gate.

The block speed calculation is just for control to be sure that the block speed on a given route is realistic. **Attention:** The block speed on long routes is higher than on short routes.

Type of Aircraft

We have to be sure that from both the passenger demand and the route stage distances' perspective the potential aircraft are suitable. In our case, the average number of tourist passengers per departure is 276, the average number of business passengers per departure is 17 and the maximum route stage distance is 9,200 km. To meet the demand, we set a two-class seating configuration—24 business class seats (B) and 356 tourist seats (Y)—for a total of 380 seats.

The A330-200 and B777-200ER aircraft meet both conditions. Take care that the number of seats (in our case 380) does not exceed the maximum number of seats specified by the manufacturer of the aircraft by accounting for the seating configuration. Just for your information, the maximum number of seats (only tourists) in the case of the A330-200 is 406 seats and in the case of B777-200ER, 440 seats. The range of the A330-200 is 13,450 km and the range of the B777-200ER is 13,084 km.

Students can choose any seating configuration. From a practical point of view, I suggest choosing a configuration applied by an airline flying the aircraft you have chosen.

Available Seats

Reminder: The annual seat capacity (Table 5) is calculated by multiplying the total number of seats per aircraft, per seating configuration by the number of departures (see in Table 4) stage-by-stage and then summing them up.

TABLE 5
SEAT CAPACITY

		Available seats/year		
No.	**City pairs (stages)**	**Y**	**B**	**Y+B**
1	A-B	34,176	2,304	36,480
2	B-A	34,176	2,304	36,480
3	A-C	17,088	1,152	18,240
4	C-A	17,088	1,152	18,240
5	A-D	17,088	1,152	18,240
6	D-A	17,088	1,152	18,240
7	A-E	17,088	1,152	18,240
8	E-A	17,088	1,152	18,240
9	A-F	34,176	2,304	36,480
10	F-A	34,176	2,304	36,480
	Total	**239,232**	**16,128**	**255,360**

Based on the expected demand and the number of available seats, we can establish our fleet. The number of available seats (255,360) covers the yearly demand (196,700). The available seats can be generated with one aircraft; hence, our fleet comprises one aircraft.

OPERATIONAL AND FINANCIAL PLAN

Our plan covers one year of operation.

Available Output (Capacity)

Reminder: Available seat kilometres (ASK) are obtained by multiplying the number of seats (see Table 5) available for sale on each flight by the flight stage distance flown (see Table 2) and then summing them up.

Aircraft kilometres flown are obtained by multiplying the number of departures (see Table 4) by the flight stage distances (by GCD) stage-by-stage and then summing them up (Table 6).

TABLE 6
CAPACITY

No.	City pairs (stages)	Available output (Capacity) (ASK)	Aircraft kilometres flown
1	A-B	80,256,000	211,200
2	B-A	80,256,000	211,200
3	A-C	150,480,000	396,000
4	C-A	150,480,000	396,000
5	A-D	167,808,000	441,600
6	D-A	167,808,000	441,600
7	A-E	155,040,000	408,000
8	E-A	155,040,000	408,000
9	A-F	58,368,000	153,600
10	F-A	58,368,000	153,600
	Total	**1,223,904,000**	**3,220,800**

Summary and calculations

Indicators (network level)	Value	Equations used
P_a – Available output (Capacity) (ASK)	1,223,904,000	
N_s – Number of available seats	255,360	
$\bar{l}_h$ – Seat-haul average (km)	4,793	$\bar{l}_h = \frac{P_a}{N_s}$
l_f – Kilometres flown (km)	3,220,800	
N_d – Number of departures	672	
$\bar{l}_s$ – Average stage length (km)	4,793	$\bar{l}_s = \frac{l_f}{N_d}$

Reminder: Average stage length is the average distance flown per aircraft departure.
The seat-haul distance (in short, “seat-haul”) is the average distance of hauling one aircraft seat (empty or occupied) on the network during the planned period. The definition of seat-haul we use as an explanation of the “network effect” (Chapter 3.3).

The average stage length equals seat-haul; you will find the proof in Appendix 5.2.

Revenue Output (Traffic)

Reminder: Revenue passenger kilometres (RPK) are obtained by multiplying the number of fare-paying passengers on each flight stage by flight stage distance (see Table 2) and then summing them up (Table 7).

TABLE 7
TRAFFIC (RPK)

No.	City pairs (stages)	Revenue passengers	Revenue output (Traffic) (RPK)
		Total	
1	A-B	27,100	59,620,000
2	B-A	27,100	59,620,000
3	A-C	14,000	115,500,000
4	C-A	14,000	115,500,000
5	A-D	14,700	135,240,000
6	D-A	14,700	135,240,000
7	A-E	14,950	127,075,000
8	E-A	14,950	127,075,000
9	A-F	27,600	44,160,000
10	F-A	27,600	44,160,000
	Total	**196,700**	**963,190,000**

Summary and calculations

Indicators (network level)	**Value**	**Equations used**
P_r – Revenue output (Traffic) (RPK)	963,190,000	
N_r – Number of revenue passengers carried	196,700	
$\bar{l}_t$ – Average trip length or passenger-haul (km)	4,897	$\bar{l}_t = \frac{P_r}{N_r}$

Load Factor

Reminder: Passenger load factor (%) is revenue output (RPK) expressed as a percentage of available output (ASK) (Table 8). The seat occupancy (%) is the number of passengers carried as a percentage of seats available for sale. The load factor and the seat occupancy on a single stage are equal but, on the network, they are usually different from each other. This difference will lead us to the phenomenon of the network effect (see Chapter 3.3).

TABLE 8
LOAD FACTOR AND SEAT OCCUPANCY

No.	City pairs	Revenue output (Traffic) (RPK)	Available output (Capacity) (ASK)	Load factor	Revenue passengers	Available seats	Seat occupancy or Seat load factor
1	A-B	59,620,000	80,256,000	74.29%	27,100	36,480	74.29%
2	B-A	59,620,000	80,256,000	74.29%	27,100	36,480	74.29%
3	A-C	115,500,000	150,480,000	76.75%	14,000	18,240	76.75%
4	C-A	115,500,000	150,480,000	76.75%	14,000	18,240	76.75%
5	A-D	135,240,000	167,808,000	80.59%	14,700	18,240	80.59%
6	D-A	135,240,000	167,808,000	80.59%	14,700	18,240	80.59%
7	A-E	127,075,000	155,040,000	81.96%	14,950	18,240	81.96%
8	E-A	127,075,000	155,040,000	81.96%	14,950	18,240	81.96%
9	A-F	44,160,000	58,368,000	75.66%	27,600	36,480	75.66%
10	F-A	44,160,000	58,368,000	75.66%	27,600	36,480	75.66%
	Total	**963,190,000**	**1,223,904,000**	**78.70%**	**196,700**	**255,360**	**77.03%**

Summary and calculations

Indicators (network level)	**Value**	**Equations used**
λ – Passenger load factor	78.70%	$\lambda=\frac{P_r}{P_a}$
λ_s – Seat occupancy	77.03%	$\lambda_s=\frac{N_r}{N_s}$
d_n – Network effect coefficient	1.0217	$d_n=\frac{\bar{l}_t}{\bar{l}_h}$
Load factor cross check	78.70%	$\lambda=\lambda_s d_n$
λ_b – Break-even load factor	72.27%	$\lambda_b=\frac{c}{y}$

Attention: Take notice of the difference between load factor and seat occupancy on the network level.

Revenue and Yield

Reminder: Yield is the average revenue collected per passenger kilometre (RPK) (Table 9). Passenger yield is calculated by dividing the total passenger revenue on a flight or on a network by the Traffic (passenger kilometres generated).

TABLE 9
REVENUE

No.	City pairs	Passenger fare (average in USD)		Revenue from ticket sales (USD)			Revenue output from Table 7 (Traffic) (RPK)	Yield (USD/ RPK)
		Y	**B**	**Y**	**B**	**Total**		
1	A-B	190	620	4,902,000	805,350	5,707,350	59620,000	0.0957
2	B-A	190	620	4,902,000	805,350	5,707,350	59,620,000	0.0957
3	A-C	420	1.330	5,502,000	1,197,000	6,699,000	115,500,000	0.0580
4	C-A	420	1.330	5,502,000	1,197,000	6,699,000	115,500,000	0.0580
5	A-D	440	1.450	5,984,000	1,595,000	7,579,000	135,240,000	0.0560
6	D-A	440	1.450	5,984,000	1,595,000	7,579,000	135,240,000	0.0560
7	A-E	430	1.350	6,063,000	1,147,500	7,210,500	127,075,000	0.0567
8	E-A	430	1.350	6,063,000	1,147,500	7,210,500	127,075,000	0.0567
9	A-F	140	590	3,668,000	826,000	4,494,000	44,160,000	0.1018
10	F-A	140	590	3,668,000	826,000	4,494,000	44,160,000	0.1018
	Total			**52,238,000**	**11,141,700**	**63,379,700**	**963,190,000**	**0.0658**

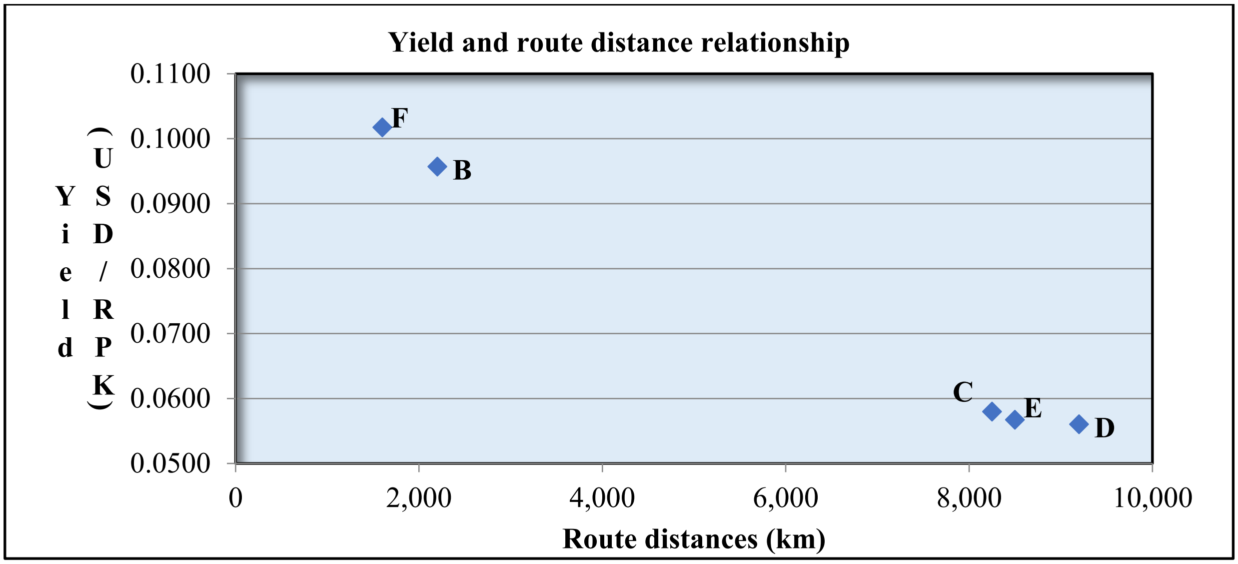
Summary and calculations

Indicators (network level)	**Value**	**Equations used**
R – Passenger revenue (USD)	63,379,700	
y – Yield (USD/RPK)	0.0658	$y=\frac{R}{P_r}$
$\bar{f}_p$ – Average passenger fare (USD)	322	$\bar{f}_p=\frac{R}{N_r}$
Yield cross check	0.0658	$y=\frac{\bar{f}_p}{\bar{l}_t}$
r – Unit revenue (USD/ASK)	0.0518	$r=\frac{R}{P_a}$
r_s – Revenue per available seat (USD)	248	$r_s=\frac{R}{N_s}$

The yield falls as average trip length increases (see equation for yield cross check), assuming a slower increase of the average fare. If we consider that fares increase with route distance not in a linear way, then, as a result, the yield will fall as average trip length increases.

Yield should decline with route distance as well. Let’s see how this relationship looks like in our case (Figure 2).

FIGURE 2
THE LONGER THE DISTANCE TO THE DESTINATION THE LOWER THE YIELD



Costs and Unit Cost

Reminder: Unit cost is a measure obtained by dividing total operating cost by the Capacity (ASK). We make rough cost estimation (Table 10) based on analysis of the cost's breakdown of some airlines. Students should apply real cost estimations.

TABLE 10
COST BREAKDOWN

Cost breakdown	USD	Ratio (%)
Aircraft fuel	13,900,000	23.87%
Wages, salaries and benefits	15,949,500	27.39%
Airport and navigation fees	3,900,000	6.70%
Aircraft maintenance	4,800,000	8.24%
Depreciation	5,740,000	9.86%
Sales and distribution costs	3,100,000	5.32%
Communications and information technology	1,450,000	2.49%
Other	3,500,000	6.01%
Total excluding catering and onboard services	**52,339,500**	**89.87%**
Catering and onboard services	5,901,000	10.13%
Total operating costs	**58,240,500**	**100.,00%**

Summary and calculations

Indicators (network level)	**Value**	**Equations used**
C – Operating costs (USD)	58,240,500	
c – Unit cost (USD/ASK)	0.0476	$c=\frac{C}{P_a}$

c_s – Average cost per seat (USD/seat)	228	$c_s = \frac{C}{N_s}$
Unit cost cross check	0.0476	$c = \frac{c_s}{\bar{l}_h}$
C_p – On-board passenger services cost (USD)	5,901,000	
c_p – On-board services cost per PAX (USD)	30	$c_p = \frac{C_p}{N_r}$

Modifying the number of passengers carried, *ceteris paribus* (all other things remaining constant), the unit cost will change because of the catering and on-board passenger service cost changes (in general because of the load-related costs change). This is the reason why the catering and the on-board passenger service cost are treated separately. This approach gives more precise results of calculations in the **What-If** analysis (see Chapter 3). In the case where you are creating a Low-Cost Carrier (LCC), there is no on-board passenger service cost and no need to separate this cost.

Profit

The economic result (Profit or Loss) can be calculated by using three different equations. The result should be the same in all three cases. You can find all the necessary data to calculate the Profit in Table 11.

TABLE 11
PROFIT CALCULATION

Indicators (network level)	Value	Equations used
E - Economic result (Profit or loss)		
E=	5,139,200	1. E = R – C
E=	5,139,200	2. $E = P_a(\lambda y - c)$
E=	5,139,200	3. $E = P_a(r - c)$
R - Revenue (USD)	63,379,700	
C - Operating cost (USD)	58,240,500	
P_a - Available output (Capacity) (ASK)	1,223,904,000	
λ - Load factor	78.70%	
y - Yield (USD/RPK)	0.0658	
c - Unit cost (USD/ASK)	0.0476	
r - Unit revenue (USD/ASK)	0.0518	

Important notice: If you check my calculations, then you will find that the result E of Equations (2) and (3) differs from the result of Equation (1). This difference is caused by the number of decimals. The number of decimal places is four as a maximum in this paper. I have made all calculations in Excel, where the number of decimal places is limited only by the Excel program. In checking my calculations, please recalculate the load factor, yield, unit cost and unit revenue for decimals using the Excel program and the input data of Chapter 1.

Operating and Financial Statistics

A summary of the most relevant indicators of our plan is seen in Table 12.

TABLE 12
OPERATING AND FINANCIAL STATISTICS

No	Operation: Traffic and Capacity	Value
1	Passengers carried	196,700
2	Seat capacity (available seats)	255,360
3	Available seat km (ASK)	1,223,904,000
4	Revenue passenger km (RPK)	963,190,000
5	Passenger load factor	78.70%
	Financial	
6	**Passenger revenue (USD)**	**63,379,700**
7	Passenger revenue per RPK (Yield)	0.0658
8	Passenger revenue per ASK (Unit revenue)	0.0518
9	Average passenger fare (USD/PAX)	322
10	Revenue per available seat (USD/Seat)	248
11	**Cost of operation (USD)**	**58,240,500**
12	Unit cost (USD/ASK)	0.0476
13	Cost per available seat (USD/Seat)	228
14	**Operating Profit (USD)**	**5,139,200**
	Additional indicators of operation	
15	Seat occupancy	77.03%
16	Break-even load factor	72.32%
17	Number of departures	672
18	Aircraft kilometres flown	3,220,800
19	Average trip length (km)	4,897
20	Seat-haul (stage length)	4,793
21	Network effect coefficient	1.0217

WHAT-IF ANALYSIS

We are offering Capacity for sale based on our schedule. The capacity (available output) and the unit cost can be regarded as constant in a draft **plan** version in which the network and the airline flight schedule finalised during the **planning** process. We will now answer some questions the management of our company could raise before approving the plan:

- **How** will we reach the *same Profit* target with combinations of load factor and yield (Chapter 3.1)?
- **What** will the Profit be in the case of different load factor and yield target combinations (Chapter 3.2)?
- **What** is the impact of the passenger distribution change on the Traffic (Chapter 3.3)?

Based on the analysis results, management can decide whether to modify the plan or leave it as it is and approve it. We mark the original plan's data with yellow colour throughout in this chapter.

Load Factor Versus Yield (Isoprofit Curves)

There is an inverse relationship between the yield and load factor; i.e. in order to reach the *same Profit* when yield is decreasing, we have to increase load factor and vice versa.

We set up different numbers of passengers below and above the planned number, which results in different load factors (Table 13). It is assumed that the distribution of passengers on the network for all versions (from v1 to v5) is the same as in the plan; in other words, the average trip length and the network effect coefficient are the same as well.

For the load factor calculation, we use the following equation:

$$\lambda = \frac{N_r}{N_s} d_n$$

TABLE 13
PASSENGERS CARRIED AND THE LOAD FACTOR

Versions				
v1	**v2**	**Plan**	**v4**	**v5**
Passengers carried				
188,700	192,700	196,700	200,700	204,700
Change in the number of PAX carried compared to planned				
−8,000	−4,000	0	4,000	8,000
Load factor				
75.50%	77.10%	78.70%	80.30%	81.90%

Operating costs contains costs that depends on the number of passengers carried (on-board passenger service cost).

Having our 30 USD/PAX on-board passenger service cost, we recalculate the unit cost for each version (Table 14). Students can change (increase or decrease) this passenger-related cost and see how the unit cost is changing.

TABLE 14
UNIT COST IN RELATION TO NUMBER OF PASSENGERS CARRIED

v1	v2	Plan	v4	v5
Change in on-board passenger service cost (USD)				
−240,000	−120,000	0	120,000	240,000
Operating cost depending on the number of passengers carried				
58,000,500	58,120,500	58,240,500	58,360,500	58,480,500
Unit cost depending on the number of passengers carried				
0.0474	0.0475	0.0476	0.0477	0.0478

We set different Profit targets and calculate the yield to present the inverse relationship between load factor and yield. Our aim is to demonstrate how the *same Profit* target could be reached with different combinations of yield and load factor.

Remember: the available output is the same in all versions as in the plan. We calculate the yield (Table 15) using the following equation, which is derived from the Profit Equation (2) (see Table 11):

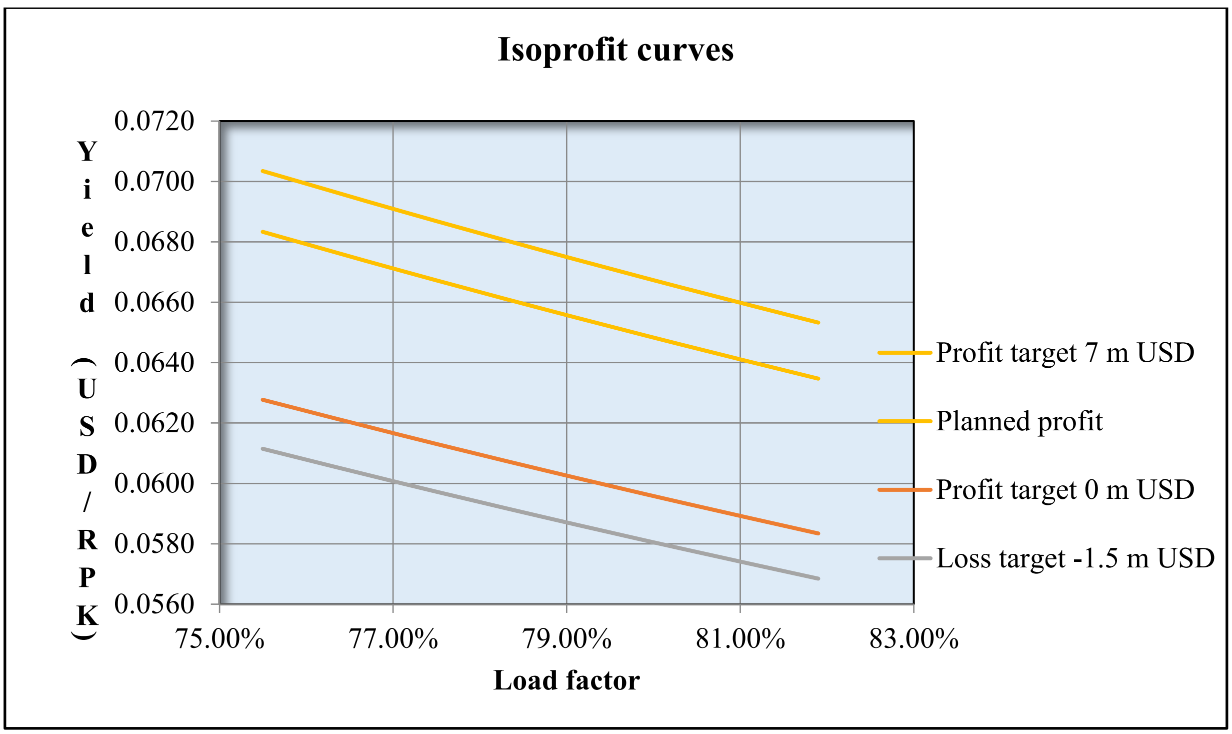
$$y = \frac{\frac{E}{P_a} + c}{\lambda}$$

TABLE 15
YIELD CALCULATIONS AND LOAD FACTOR

Profit target (USD)	v1	v2	Plan	v4	v5
	Yield (USD/RPK)				
4,000,000	0.0671	0.0658	0.0646	0.0635	0.0623
5,139,200	0.0683	0.0670	0.0658	0.0646	0.0635
7,000,000	0.0703	0.0690	0.0677	0.0665	0.0653
0	0.0628	0.0616	0.0605	0.0594	0.0583
−1,500,000	0.0611	0.0600	0.0589	0.0579	0.0568
	Load factor (see Table 13)				
	75.50%	77.10%	78.70%	80.30%	81.90%

Our planned Profit target of 5,139,200 (USD) could be reached with any combination of an increasing load factor from 75.50% to 81.90% and decreasing yield from 0.0683 to 0.0635 (USD/RPK). We can set a loss target as well if necessary. Management can set any other Profit target and choose the most suitable combination of yield and load factor for a revised plan. We have all information to present the inverse relationship on the diagram now (Figure 3). The four million Profit target is not presented on the diagram intentionally for better transparency.

FIGURE 3
ANY COMBINATION OF THE YIELD AND THE LOAD FACTOR RESULTS IN THE PROFIT TARGET



We can present how the average passenger fare is changing in relation to the yield (Table 16). We get the average passenger fare by multiplying the yield by the average trip length:

$$\bar{f}_p = y\bar{l}_t.$$

When the Profit equals zero, we are at the break-even point. The break-even average passenger fare is important information because below this fare the airline enters into loss.

TABLE 16
AVERAGE PASSENGER FARE

Profit target (USD)	**v1**	**v2**	**Plan**	**v4**	**v5**
	Average passenger fare (USD)				
4,000,000	329	322	316	311	305
5,139,200	335	328	322	316	311
7,000,000	344	338	332	326	320
0 (break-even)	307	302	296	291	286
−1,500,000	299	294	288	283	278

We now look at the revenue for every version (Table 17). We get the passenger revenue by multiplying the number of revenue passengers by the average fare.

$$R = N_r\bar{f}_p.$$

TABLE 17
REVENUE IN DIFFERENT VERSIONS

Profit target (USD)	**v1**	**v2**	**Plan**	**v4**	**v5**
	Revenue (USD)				
4,000,000	62,000,500	62,120,500	62,240,500	62,360,500	62,480, 500
5,139,200	63,139,700	63,259,700	63,379,700	63,499,700	63,619,700
7,000,000	65,000,500	65,120,500	65,240,500	65,360,500	65,480,500
0	58,000,500	58,120,500	58,240,500	58,360,500	58,480,500
−1,500,000	56,500,500	56,620,500	56,740,500	56,860,500	56,980,500

Load Factor–Yield Matrix

What will the revenue and Profit be if we apply combinations of different load factors and different yield targets?

The different load factors mean a different number of passengers and different unit costs due to the change of the passenger service cost. It is assumed that the average trip length is the same in all versions; that is, the network effect coefficient is constant (1.0217). The changes are calculated compared with the original plan's data.

We define the total number of passengers carried with the equation:

$$N_r = \lambda \frac{N_s}{d_n}.$$

We round up the result (number of passengers) because it should be an integer.

We calculate now the unit cost depending on the number of passengers carried (Table 18).

TABLE 18
UNIT COST DEPENDING ON THE NUMBER OF PASSENGERS CARRIED

LF target	Passengers carried	Number of PAX change	Passenger service cost change (USD)	Operating cost (USD)	Unit cost (USD/ASK)
76.00%	189,957	−6,743	−202,290	58,038,210	0.0474
78.00%	194,955	−1,745	−52,350	58,188,150	0.0475
78.70%	196,700	0	0	58,240,500	0.0476
80.00%	199,954	3,254	97,620	58,338,120	0.0477
82.00%	204,953	8,253	247,590	58,488,090	0.0478

To arrive at the revenue and then to the Profit, we define the related average passenger fare by multiplying the targeted yield by the average trip length, applying the equation:

$$\bar{f}_p = y\bar{l}_t$$

As we have seen earlier in Chapter 3.1, the passenger revenue is a product of the number of revenue passengers carried and the average passenger fare:

$$R = N_r\bar{f}_p$$

and, finally the Profit:

$$E = R - C.$$

If you cross check the Profit with Equation (2) (see Table 11), then you will find a minor difference between the two results. The reason lies in the rounding up the number of passengers to make these values to be integers.

You can find the results of these calculations in Table 19.

TABLE 19
LOAD FACTOR-YIELD MATRIX

	Yield target (USD/RPK)				
	0.0618	0.0638	0.0658	0.0678	0.0698
	Average passenger fare (USD)				
	303	312	322	332	342
LF Target	**Passenger revenue**				
76.00%	57,486,319	59,346,661	61,207,004	63,067,346	64,927,689
78.00%	58,998,854	60,908,144	62,817,435	64,726,725	66,636,015
78.70%	59,526,940	61,453,320	63,379,700	65,306,080	67,232,460
80.00%	60,511,692	62,469,940	64,428,188	66,386,436	68,344,684
82.00%	62,024,529	64,031,735	66,038,941	68,046,146	70,053,352

	Profit E = R − C				
76.00%	−551,891	1,308,451	3,168,794	5,029,136	6,889,479
78.00%	810,704	2,719,994	4,629,285	6,538,575	8,447,865
78.70%	1,286,440	3,212,820	5,139,200	7,065,580	8,991,960
80.00%	2,173,572	4,131,820	6,090,068	8,048,316	10,006,564
82.00%	3,536,439	5,543,645	7,550,851	9,558,056	11,565,262

Management can ask during the plan approval process; for example, what will be the Profit if we set the load factor target to 82% (increasing the number of revenue passengers) but do not increase the average fare of 322 USD?

The answer is: 7,550,851 USD. By applying different load factor and yield (average passenger fare) targets, management can fine-tune the plan to reach the desired Profit.

Network Effect

What happens if the demand for longer travel distances is prevailing over the demand for shorter travel distances?

The shift of passengers to higher travel distances (while the total number of passengers remains constant) will lead to higher revenue output and to higher Profit. Conversely, the shift of passengers to shorter travel distances (while the total number of passengers remains constant) will lead to lower revenue output and to lower Profit.

In our example, we increase the number of passengers on the long routes and decrease it on the short routes such that the number of passengers constant (Table 20). As a result, the average trip length increases (Table 22) as does the revenue output (Table 21).

TABLE 20
VERSIONS OF PASSENGER DISTRIBUTION ON THE NETWORK

No.	City pairs	Flight stage distances (km)	Passengers distribution on the network (PAX)					
			Plan	**v1**	**v2**	**v3**	**v4**	**v5**
1	A-B	2,200	27,100	26,600	26,400	26,300	26,200	26,000
2	B-A	2,200	27,100	26,600	26,400	26,300	26,200	26,000
3	A-C	8,250	14,000	14,500	14,800	14,800	15,000	15,100
4	C-A	8,250	14,000	14,500	14,800	14,800	15,000	15,100
5	A-D	9,200	14,700	14,700	14,750	14,850	14,850	14,950
6	D-A	9,200	14,700	14,700	14,750	14,850	14,850	14,950
7	A-E	8,500	14,950	14,950	15,000	15,100	15,200	15,400
8	E-A	8,500	14,950	14,950	15,000	15,100	15,200	15,400
9	A-F	1,600	27,600	27,600	27,400	27,300	27,100	26,900
10	F-A	1,600	27,600	27,600	27,400	27,300	27,100	26,900
		Total	**196,700**	**196,700**	**196,700**	**196,700**	**196,700**	**196,700**

TABLE 21
REVENUE OUTPUT (TRAFFIC) IN DIFFERENT VERSIONS OF PASSENGER DISTRIBUTION

No.	City pairs	Revenue output (Traffic) (RPK)					
		Plan	**v1**	**v2**	**v3**	**v4**	**v5**
1	A-B	59,620,000	58,520,000	58,080,000	57,860,000	57,640,000	57,200,000
2	B-A	59,620,000	58,520,000	58,080,000	57,860,000	57,640,000	57,200,000
3	A-C	115,500,000	119,625,000	122,100,000	122,100,000	123,750,000	124,575,000
4	C-A	115,500,000	119,625,000	122,100,000	122,100,000	123,750,000	124,575,000
5	A-D	135,240,000	135,240,000	135,700,000	136,620,000	136,620,000	137,540,000
6	D-A	135,240,000	135,240,000	135,700,000	136,620,000	136,620,000	137,540,000
7	A-E	127,075,000	127,075,000	127,500,000	128,350,000	129,200,000	130,900,000
8	E-A	127,075,000	127,075,000	127,500,000	128,350,000	129,200,000	130,900,000
9	A-F	44,160,000	44,160,000	43,840,000	43,680,000	43,360,000	43,040,000
10	F-A	44,160,000	44,160,000	43,840,000	43,680,000	43,360,000	43,040,000
	Total	**963,190,000**	**969,240,000**	**974,440,000**	**977,220,000**	**981,140,000**	**986,510,000**

Reminder: Revenue output is obtained by multiplying the number of fare-paying passengers on each flight stage by the flight stage distance and then summing the results.

TABLE 22
ADDITIONAL DATA TO BUILD UP THE NETWORK EFFECT DIAGRAM (FIGURE 4)

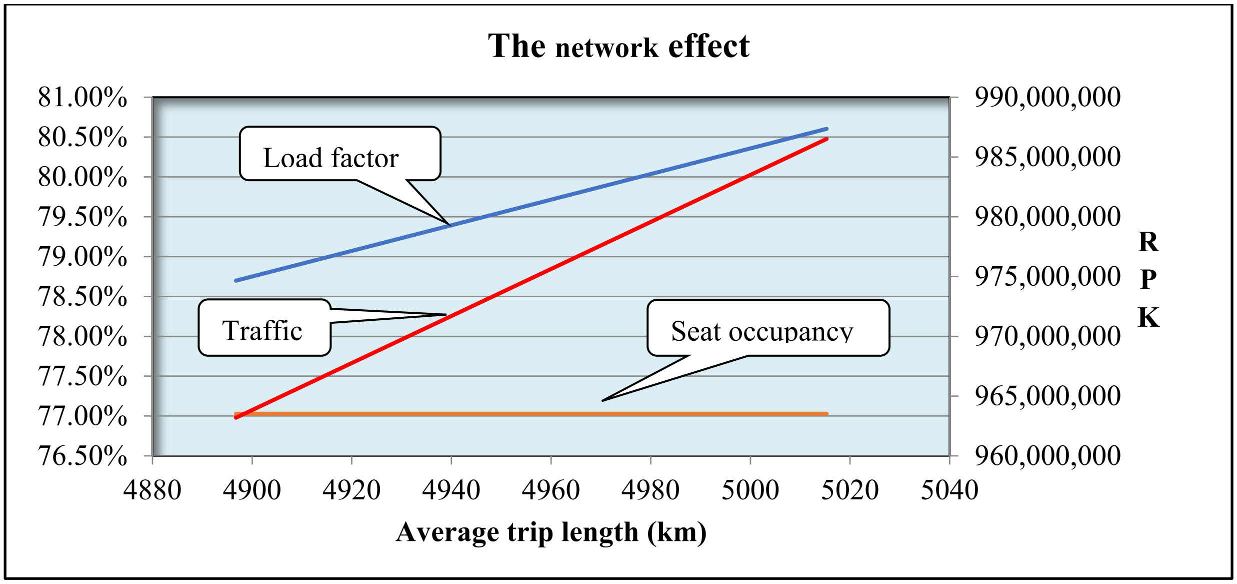
	Plan	**v1**	**v2**	**v3**	**v4**	**v5**
Average trip length (km)	4,897	4,928	4,954	4,968	4,988	5,015
Difference between the average trip length and the average seat-haul (km)	104	135	161	175	195	222
Network effect coefficient	1.0217	1.0281	1.0336	1.0366	1.0407	1.0464
Passenger load factor	78.70%	79.19%	79.62%	79.84%	80.16%	80.60%
Seat occupancy	77.03%	77.03%	77.03%	77.03%	77.03%	77.03%
Traffic increase compared to planned (RPK)		6,050,000	11,250,000	14,030,000	17,950,000	23,320,000

Just to remind you that in our plan, the average seat-haul is 4,793 km and the available output (Capacity) is 1,223,904,000 ASK (see Table 6).

Indicators for additional data calculations	**Equations used**
λ - Passenger load factor	$\lambda = \frac{P_r}{P_a}$
λ_s - Seat occupancy	$\lambda_s = \frac{N_r}{N_s}$
$\bar{l}_t$ - Average trip length or passenger-haul (km)	$\bar{l}_t = \frac{P_r}{N_r}$

d_n - Network effect coefficient $$d_n = \frac{\bar{l}_t}{\bar{l}_h}$$

FIGURE 4
SHIFT OF PASSENGERS TO THE LONGER TRIP LENGTH RESULTS IN INCREASED LOAD FACTOR AND TRAFFIC WHILE THE SEAT OCCUPANCY (TOTAL NUMBER OF PASSENGERS) REMAINS UNCHANGED



CONCLUSION

To set up an airline is much more complicated than I did in this paper. I just wanted to focus on the relationship between the Key Performance Indicators of airline economics. My intention was also to demonstrate the possible applications of the Profit model: $E = P_a(\lambda y - c)$. The Profit model can be used as a tool to adjust costs, yields (fares) and load factors to produce profitable combinations during the planning phase of an airline's financial plan.

Students can make the calculation more complicated compared with my version, for example, by choosing more destinations, different seat configurations, adding cargo, defining the proper aircraft type and making detailed cost calculations and building a network effect diagram when the shorter travel distances are prevailing over longer travel distances etc.

I suggest writing a software program to ease the planning and the **What-If** analysis calculations.

Dear Student, do not hesitate to create Your Airline!

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APPENDIX

Notation

Symbol	Designation	Measure
Pa	Available output (Capacity)	Available Seat Kilometres (ASK)
Pr	Revenue output (Traffic)	Revenue Passenger Kilometres (RPK)
R	Passenger revenue	(USD)
C	Operating costs	(USD)
Cp	On-board passenger services cost	(USD)
E	Economic result (Profit or Loss)	(USD)
λ	Passenger load factor	(%)
λb	Break-even load factor	(%)
λs	Seat occupancy or seat load factor	(%)
y	Yield	(USD/RPK)
c	Unit cost	(USD/ASK)
cs	Average cost per seat	(USD/seat)
cp	Average on board passenger services cost	(USD/PAX)
Ns	Number of available seats	(Seats)
Nr	Number of revenue passengers carried	(PAX)
Nd	Number of departures	
dn	Network effect coefficient	
$\bar{f}_p$	Average passenger fare	(USD)
r	Unit revenue	(USD/ASK)
rs	Revenue per available seat	(USD/seat)
$\bar{l}_t$	Average trip length or passenger-haul	(km)
$\bar{l}_h$	Seat-haul average	(km)
$\bar{l}_s$	Average stage length	(km)
lf	Kilometres flown	(km)

Average Stage Length and Seat-Haul

As mentioned in the Chapter 2.1, the average stage length equals seat-haul. Here is the proof:
Average stage length:

$$\bar{l}_s = \frac{l_f}{N_d}$$

Available output can be calculated as:

$$P_a = \bar{l}_h N_s \qquad \text{or} \qquad P_a = \frac{l_f N_s}{N_d} = \bar{l}_s N_s$$

As a consequence:

$$\bar{l}_h N_s = \bar{l}_s N_s$$

and, finally, after reduction with the number of seats:

$$\bar{l}_h = \bar{l}_s.$$