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## DEVELOPMENT OF POTENTIAL AIR TRANSPORTATION ROUTE: CASE OF UKRAINE INTERNATIONAL AIRLINES

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**Abstract.** Ukraine International Airlines serve most of the aviation market in Ukraine and it takes the responsibility for high level of efficient functioning for passengers. One of the way how to improve airline's development is to open new direct flight from Kiev to Cairo as due to break-even analysis this route attracts a lot of tourists accordingly it bring great income for the company.

**Keywords:** Ukraine International Airlines, route, direct, flight, timetable design, costs, efficiency, break-even analysis.

### Introduction

Ukraine International Airlines (UIA) is the flag carrier and the largest airline of Ukraine. Today UIA operates 1100 international and domestic flights per week to over 3,000 destinations, offering convenient connections across the globe at competitive prices.

Nowadays, one of the major task of the airline is to develop the high level of service for passengers as low-cost airlines became great competitor for the UIA. In the article, the possibility of new route development is considered. The idea of research is to present the direct route Kiev–Cairo (KBP–CAI) operated by Ukrainian International Airlines as it will bring a convenience for passengers and profit for the company.

### Potential Route Map Kiev–Cairo

The lowest One Way route is Boryspil International Airport (KBP) – Istanbul Atatürk Airport (IST) – Sharm El Sheikh Airport (SSH) – Cairo International Airport (CAI), the Round Trip one – Boryspil International Airport (KBP) – Sheremetyevo International Airport (SVO) – Cairo International Airport (CAI). The similar price value also contains the route KBP-IST-SSH-CAI with the same number of flights per a week. But, the duration of flight is too long. That is why is will be better to fly according to the route Boryspil International Airport (KBP) – Odessa International Airport (ODS) – Istanbul Atatürk Airport (IST) –

Cairo International Airport (CAI) with time duration of 7 hours and 20 minutes 13 times per a week with prices per flight – OW = 6300 UAH, RT = 13 735 UAH. Operating carriers are Ukrainian International Airlines (on flight component KBP-ODS) and Turkish Airlines (ODS-IST-CAI). As a result, the most suitable route contains 2 transfer points (Table 1).

### Legislation Provision of Ukraine–Egypt Civil Aviation Flights

In order to create new direct flight, UIA should correspond to the legislation provision between Ukraine and Egypt.

The airline Ukrainian International Airlines occupies 1, 2, 3, 4, 5 and 6 freedoms of the air.

Currently, UIA has 11 code-sharing agreements; about 130 interline agreements, and 64 of the Treaty on the special conditions of settlements with other airlines to provide passengers with the opportunity to reach more than 3000 cities around the world.

EgyptAir is a member of Star Alliance. It means that partners that participate in airline alliances such as Star Alliance or SkyTeam almost always have interline agreements with each other. However even direct competitors can benefit from interline agreements.

It is necessary to take into account that both countries (Ukraine and Egypt) are signed the Montreal Protocol of Warsaw System Air Civil Market Regulations.

**Table 1.** Possible Routes in Direction KBP–CAI–KBP

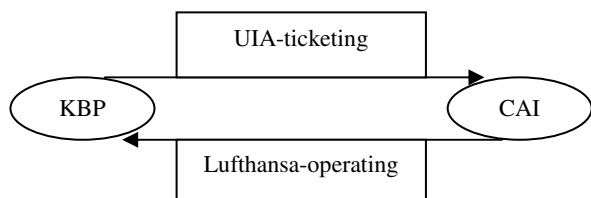
Type of Route	Airline	Points of Transfer	Aircraft	Times per Week	Time Duration	Price, UAH	
						OW	RT
KBPSVOCAI	SU	1	A321 A319	10	7 h	7514	9612
KBPMUCCAI	LH	1	A340-600 A340-300	8	8 h 45 min	8967	10 386
KBPCDGCAI	AF MS	1	A320-200 A318	7	10 h 50 min	12 336	18 949
KBPCDGCAI	PS MS	1	A320-200 A318	6	10 h 50 min	7423	12 774
KBPODS IST CAI	PS TK	2	A321-200 B737-700 B737-400	13	7 h 20 min	6300	13 735
KBP IST SSH CAI	TK MS	2	A330-300 B737-700 A318	10	12 h 10 min	4590	10 271

But, between these countries no Open Sky Agreement. It means that flight between them can be performed only according to the freedoms of the air. As we choose operating carrier Ukrainian International Airlines, it has the 1–6 freedoms of the air that provides legislative possibility to perform direct flight KBP–CAI (it is 3–4 freedoms of the air).

Also, between these countries no direct codeshare agreement, only intermediate airline Swiss which operates different destinations according to the agreement - UIA-Swiss there is a flight Zurich International Airport – Boryspil International Airport, and EgyptAir – Geneva International Airport – Cairo International Airport. It means that there is no possibility to provide flight KBP–CAI through codeshare UIA-EgyptAir and their partner Swiss.

Speaking about interline agreement, there is no also direct interline agreement, but there are partners Aeroflot, KLM&Air France and Lufthansa that can operate route KBP–CAI. But, Aeroflot and KLM&Air France has no 7<sup>th</sup> freedom of the air to perform direct flight KBP–CAI. It means that the most suitable operating carrier will be Lufthansa, which can perform flight on behalf of the UIA.

The route is shown on the fig. 1.

**Fig. 1.** Route representation

### Timetable Design

Cairo is also in every respect the centre of Egypt, as it has been almost since its founding in 969 AD. The majority of the nation's commerce is generated there, or passes through the city. The great majority of publishing houses and media outlets and nearly all film studios are there, as are half of the nation's hospital beds and univer-

sities. This has fueled rapid construction in the city –one building in five is less than 15 years old.

This astonishing growth until recently surged well ahead of city services. Homes, roads, electricity, telephone and sewer services were all suddenly in short supply. Analysts trying to grasp the magnitude of the change coined terms like “hyper-urbanization”.

That is why 90 % of flights are performed on touristic basis and 10 % -on business needs. It means that if there is a need to perform direct flight KBP–CAI it will be better to change the route KBP–ODS–IST–CAI on the new one.

This route occupies 6981 PAX/week, thus if to change it according to the forecasting data from 2014–2017 years, the probable passenger turnover on this route can be approximately 7000 PAX/week.

During the summer period in aviation and with taking into account touristic needs of passengers it will be better to perform flight 14 times per a week.

In the timetable of the UIA route KBP–ODS–IST–CAI occupies time of departure 09.45 and 19.30 every day. But, the touristic flights are very comfortable to perform in the beginning and at the end of the week. Thus, it is represented the timetable UIA to find the possible time of additional flights in Monday and Friday. The time duration of direct flight KBP–CAI is 3 hours.

According to the UIA timetable, it performs flights on Cairo in 09.45 and 19.30. It means that in Cairo UIA landing will be in 14.00 and 23.40. This time is suitable for both of airports KBP and CAI because in CAI there is no aircraft landing at that time. The possible timetables for the route CAI–KBP–KBP are expressed in Tables 2 and 3.

### Prime cost of the flight KBP–CAI

The passenger's turnover of the direction Ukraine-Egypt in 2013 was 1 349 855 PAX/year, so our direct route Kiev–Cairo occupies 27 %, which equals to 364 461 PAX/year. On the week we have 7010 PAX/week.

The flight on the route KBP–CAI–KBP is 14 times per a week (2 times per day). That is why the number of passengers per one flight will be  $7010/14 = 200$  PAX.

**Table 2.** Timetable for the route CAI–KBP

Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Departure	16.25	16.25	16.25	16.25	16.25	16.25	16.25
	03.15	03.15	03.15	03.15	03.15	03.15	03.15
Arrival	19.30	19.30	19.30	19.30	19.30	19.30	19.30
	06.30	06.30	06.30	06.30	06.30	06.30	06.30
Terminal	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI

**Table 3.** Timetable for the route CAI–KBP

Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Departure	09.45	09.45	09.45	09.45	09.45	09.45	09.45
	19.30	19.30	19.30	19.30	19.30	19.30	19.30
Arrival	13.00	13.00	13.00	13.00	13.00	13.00	13.00
	22.40	22.40	22.40	22.40	22.40	22.40	22.40
Terminal	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI	B KBP 3CAI

Company should choose the aircraft with commercial payload of 200 PAX.

The distance between KBP and CAI is 2265 km. It can be observed the medium-haul fleet.

According to the characteristics, the most suitable aircraft is Airbus A321-100/200.

The next step in investigation, when the aircraft is selected, is prime cost of flight calculation. In order to do this it is necessary to take into account all possible charges and costs, i.e.:

1. Charges on Fuel and Lubricants

$$C_F = (1 + I_{NH}) \times g \times C_{TP},$$

$C_F$  – charges on fuel and lubricants, UAH/hour;  $I_{NH}$  – non-productive airborne hours index;  $g$  – fuel input hourly average, kg/hour;  $C_{TP}$  – price of 1 ton of fuel.

So,  $C_F = 3\ 612\ 000$  UAH.

2. Charges on Complete Renewal

$$C_{CR} = \frac{N_{AM} + C_{PS}}{T_{TR} \times 100},$$

$C_{CR}$  – charges on complete renewal of the aircraft, UAH;  $N_{AM}$  – amortization quota on complete aircraft renovation (aircraft belong to the II block of basic assets – 10 %), UAH;  $C_{PS}$  – aircraft price, mln. UAH;  $T_{TR}$  – annual airborne hours, hour/year.

So,  $C_{CR} = 1836$  UAH.

3. Charges on Technical Service and Repair

$$C_{TS} = C_{AM} \times I_{TO},$$

$C_{TS}$  – charges on Technical Service and Repair, UAH/hour;  $C_{AM}$  – charges on amortization on complete aircraft renovation, UAH;  $I_{TO}$  – index, which takes into account operating expense (take equal to 0.35).

So,  $C_{TS} = 25\ 232$  UAH.

4. Social Contribution Deduction

$$D_{SN} = C_{CP} \times C_{CS},$$

$D_{SN}$  – social necessities deduction, UAH/hour;  $C_{CP}$  – charges on payment salary to crew members, UAH/hour;  $C_{CS}$  – social contribution constant (take equal to 0.487).

So,  $C_{SN} = 633$  UAH.

5. Other Flight Charges

$$C_o = \frac{L_o \times M_{ps}}{T_{FL}},$$

$C_o$  – other flying charges, UAH/hour;  $L_o$  – other flying charges index (take equal to 0.015);  $M_{ps}$  – maximum range, km;  $T_{FL}$  – time of flight, hour.

So,  $C_o = 25$  UAH.

6. Airport Charges

6.1 Cairo International Airport charges

$$C_{AP} = \frac{C_{TL} + C_{com} + C_{GK}}{T_{NF}} + I_{UA}.$$

So,  $C_{AP} = 10\ 028$  UAH.

6.2 Boryspil International Airport charges

$$C_{AP} = \frac{C_{TL} + C_{com} + C_{GK}}{T_{NF}} + I_{UA}.$$

So,  $C_{AP} = 9230$  UAH.

$C_{AP}$  – airport charges, UAH/hour;  $C_{TL}$  – total sum for take-off/landing and maintenance operations charges, UAH;  $C_{com}$  – total sum for passenger, baggage and other commercial services, UAH;  $C_{GK}$  – total sum for ground handling operations, UAH;  $I_{UA}$  – airport charges implementation (for domestic flights – 1.0, for international flights – 0.5);  $T_{NF}$  – nonstop flight time, hours.

7. Collection on Air Navigation

$$R = T \times D \times \sqrt{\frac{Gb}{50}},$$

$R$  – moving traffic handling charges, UAH;  $T$  – unique rate of service fee;  $D$  – flight distance, km  $G_b$  – take off weight, tone

So,  $R = 1\,625\,000$  UAH.

8. Horary Flight Efficiency

$$F_E = M_{PM} \times I_{CLF} \times V_p,$$

$F_E$  – hourly flight efficiency;  $M_{PM}$  – maximum payload mass, kg;  $I_{CLF}$  – consumers load factor index (take equal to 0.8);  $V_p$  – run speed, km/hour.

So,  $F_E = 7\,431\,840$  UAH.

9. Direct Costs of the Flight

$$C_D = C_F + C_{CR} + C_{TS} + C_{CP} + D_{SN},$$

$C_D$  – direct costs, UAH;  $C_F$  – charges on fuel and lubricants, UAH/hour;  $C_{CR}$  – charges on complete renewal of aircraft, UAH/hour;  $C_{TS}$  – charges on technical service and repair, UAH/hour;  $C_{CP}$  – charges on payment of salary to crew members, UAH/hour;  $D_{SN}$  – social necessities deduction, UAH/hour.

So,  $C_D = 364\,172$  UAH.

10. Indirect Costs of the Flight

$$C_1 = C_D \times 0.4 = 3\,641\,001 \times 0.4,$$

$C_1$  – indirect costs, UAH;  $C_D$  – direct costs, UAH.

So,  $C_1 = 145\,640$  UAH.

11. Airborne Hour Prime Cost

$$PP_{ah} = C_D + C_1,$$

$PP_{ah}$  – airborne hour prime cost, UAH;  $C_1$  – indirect costs, UAH;  $C_D$  – direct costs, UAH;

$PP_{ah} = 463\,942$  UAH.

12. The Tone-Kilometers Prime Cost

$$PC_{TK} = \frac{PP_{ah}}{F_e},$$

$PC_{TK}$  – tone-kilometers prime cost, UAH;  $PP_{ah}$  – airborne hour prime cost, UAH;  $F_e$  – flight efficiency.

$PC_{TK} = 0.43$  UAH.

13. Net cost per a flight

13.1 Flight KBP-CAI

$$NC_1 = PP_{ah} + C_{AP} + C_{AN} + C_o,$$

$NC_1$  – net cost per a flight KBP-CAI, UAH.

$NC_1 = 479\,870$  UAH.

13.2 Flight CAI-KBP

$$NC_2 = PP_{ah} + C_{AP} + C_{AN} + C_o,$$

$NC_2$  – net cost per a flight CAI-KBP, UAH;  $PP_{ah}$  – airborne hour prime cost;  $C_{AP}$  – airport charges, UAH/hour;  $C_{AN}$  – collections of aero navigation, UAH/hour;  $C_o$  – other flying charges, UAH/hour;

$NC_2 = 479\,045$  UAH.

14. Total net cost of the flight KBP-CAI-KBP:

$$TNC = NC_1 + NC_2,$$

$TNC$  – total net cost for flight KBP-CAI-KBP, UAH;  $NC_1$  – net cost per a flight KBP-CAI, UAH;  $NC_2$  – net cost per a flight CAI-KBP, UAH.

$TNC = 958\,915$  UAH.

In order to calculate primary cost of the flight KBP-CAI-KBP not only Airborne Hour Prime Cost shall be taken into account, but also airport and air navigation charges at both airports. Thus, the total net cost of the flight is 958915 UAH on the direction KBP-CAI-KBP.

### Break-even analysis for the route KBP-CAI

An analysis to determine the point at which revenue received equals the costs associated with receiving the revenue is called break-even analysis. This analysis calculates what is known as a margin of safety, the amount that revenues exceed the break-even point. This is the amount that revenues can fall while still staying above the break-even point.

The journey begins at the Boryspil International Airport, and ends in Cairo International airport on an Airbus A321-100/200.

Analysis of the effectiveness of the direct flight KBP-CAI has been conducted with the help of break-even graph (fig. 2).

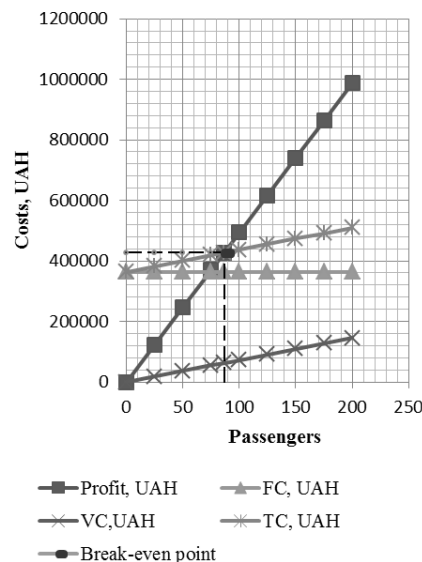


Fig. 2. Break-even analysis

Variable Costs (VC) are those costs associated with servicing passengers, such as meals services of passengers, insurance for the passengers and commissions for Travel Agent etc.

Fixed Costs (FC) are those costs not associated with the number of passengers, such as fuel costs, maintenance costs, etc.

All cost calculated are presented in the Table 4.

**Table 4.** Variable, fixed and total costs for the route KBP–CAI

Passengers	Profit, UAH	FC, UAH	VC, UAH	TC, UAH
0	0	364 172	0	364 172
25	123 350	364 172	18 205	382 377
50	246 700	364 172	36 410	400 582
75	370 050	364 172	54 615	418 787
87	427 225	364 172	63 053	427 225
100	493 400	364 172	72 820	436 992
125	616 750	364 172	91 025	455 197
150	740 100	364 172	109 230	473 402
175	863 450	364 172	127 435	491 607
200	986 800	364 172	145 640	509 812

The break-even point (BEP) is the point at which cost or expenses and revenue are equal:

$$BEP = \frac{TFC}{C} = \frac{TFC}{P - AVC},$$

where, *BEP* – break-even point; *TFC* – total fixed costs; *P* – price; *AVC* – average variable costs *BEP* = 87 passengers.

After analyzing the graph we can conclude that the critical number of passengers for the Ukraine International Airline on the direct flight “Kyiv–Cairo” is 87 passengers. When load factor for flight is 43.5 %, the airline will have no losses, no profit. If the number of passengers is less than 87 passengers, the airline incurs losses in the opposite case (when load factor of flight more than 43.5 % or 87 passengers) airline will make a profit.

So, the break-even analysis is the most important tool for making decision by airlines, especially in Commercial Department/Revenue Management where airlines policies might be built to increase revenue and the most important elements for analysis are these values and assumptions which provided by company’s final financial

accounts report. Also it shows the appropriate capacity for this aircraft in this sector/route.

### Conclusion

Flight planning is the process of producing a flight plan to describe a proposed aircraft flight. It involves two safety-critical aspects: fuel calculation, to ensure that the aircraft can safely reach the destination, and compliance with air traffic control requirements, to minimize the risk of mid-air collision. In addition, flight planners normally wish to minimize flight cost by appropriate choice of route, height, and speed, and by loading the minimum necessary fuel on board.

The idea of the research is to show the efficiency of the direct route KBP-CAI opening by the Ukrainian International Airlines.

The price of the designed route KBP-CAI-KBP is much more less than the price of already existing flights which are indicated in the Table 1. The RT of the designed route KBP-CAI-KBP can cost 4934 UAH. That is why it is necessary to change the existing route KBP-ODS-IST-CAI on the new one KBP-CAI-KBP.

### References:

- Belobaba, P.; Odoni, A.; Barnhart, C. May 26, 2009. *The Global Airline Industry*. 518 p.
- Cairo International Airport. Available from Internet: <<http://www.cairo-airport.info/>>.
- Kyiv Boryspil International Airport. Available from Internet: <<http://kbp.aero/en/>>.
- Leseure M. 2010. *Key Concepts in Operations Management*. 312 p.
- Ukraine International Airlines. Available from Internet : <<http://www.flyuia.com/eng/>>.
- Vasigh B.; Fleming K.; Mackay L. 2010. *Foundations of Airline Finance: Methodology and Practice*. 444 p.
- Vasigh B.; Tacker T.; Fleming K. 2008. *Introduction to Air Transport Economics: From Theory to Applications*. 358 p. Available from Internet: <<http://www.komaristaya.ru/stud/introduction.to.air.transport.economics.pdf>>.